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ABSTRACT

This manual on mowing and spraying equipment is one of a series of power mechanics texts and visual aids on servicing of automotive and off-the-road agricultural and construction machinery. Materials provide basic information and illustrations for use by vocational students and teachers as well as shop servicemen and laymen. Focusing on mowing cutter bars, the first of two parts addresses topics such as types of cutter bars; cutter bar components; maintenance and adjustment; adjusting the cutter bar, knife, guards, cutter bar lead, the operating height, and the cutter bar tilt; removing and repairing the knife; and servicing the guards and shoes. Part 2 focuses on spraying nozzles and addresses topics such as flow rate, atomization, types of nozzles, calibrating the application rate, checking nozzle tip flow rate, problems with nozzles, cleaning of nozzles, and calibration formulas. Each part concludes with test questions. Answers to the test questions are appended. (A supplementary slide set is also available--see availability note.) (LRA)

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FOS

Fundamentals of Service

Mowing and Spraying Equipment

CE 025 212

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TO THE READER

PURPOSE OF THIS MANUAL

The main purpose of this manual is to train the reader so that he can understand mowing and spraying equipment and service it with speed and skill. Starting with "how it works," we build up to "why it fails" and "what to do about it." This manual is also an excellent reference for the trained serviceman who wants to refresh his memory on mowing and spraying equipment. It is written in a simple form using many illustrations so that it can be easily understood.

WHAT IS "FUNDAMENTALS OF SERVICE"?

This manual is part of a series of texts and visuals called "Fundamentals of Service", or "FOS". These materials are basic information in power mechanics for use by teachers as well as shop servicemen and the layman. All types of modern equipment are covered — both automotive and off-the-road. Emphasis is on theory of operation, diagnosis, and repair.

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MOWING CUTTER BARS / PART 1

Fig. 1 — Mower Being Prepared For Operation

INTRODUCTION

Mowing cutter bars are used to cut grass, hay, and other crops by the shearing action of a reciprocating knife. Cutter bars are used on field mowers, grain combines, forage harvesters, and windrowers.

Knife sharpness and proper adjustment are the most important factors to keep in mind while reading this section. Cutter bar operation, types, care, adjustment, repair, and maintenance will be explained.

The operation of a cutter bar can be compared to the operation of hedge trimming shears (Fig. 2).

The knife moves back and forth over guard surfaces, cutting with each stroke. Fig. 3 shows the knife stroke area. The knife is pushed and pulled by either a pitman drive or pitmanless drive. We will explain these later.

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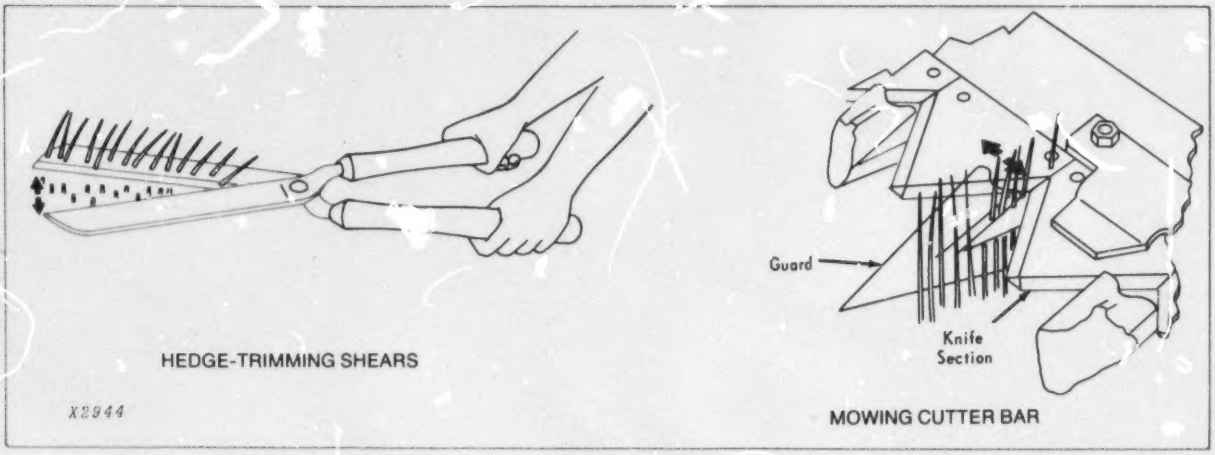

Fig. 2 — Mowing Cutter Bars Operate On The Same Principle As Hedge Trimming Shears

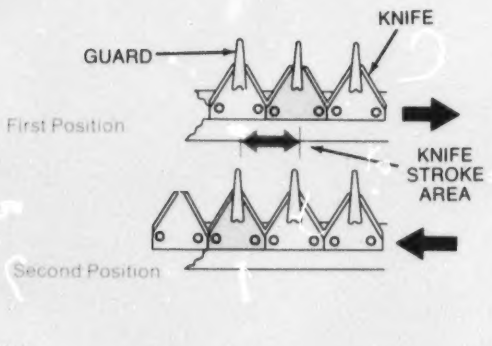

Fig. 3 — Knife Stroke Area

TYPES OF CUTTER BARS

In addition to the mower cutter bar shown in Fig. 1, there are similar cutter bars on grain combines, forage harvesters, and windrowers (Fig. 4). The cutter bar on these machines is supported on both ends.

The cutter bar on any of these machines could be like one of those shown in Fig. 5. Cutter bars equipped with **lip-type guards** are the most commonly used to cut grass and hay crops. Cutter bars equipped with **lipless guards** are used to cut crops where choking is a problem. For dense or matted crops, cutter bars equipped with **double knives** are used. Special cutter bars are also available.

These may be equipped with heavy-duty, narrow-spaced, or plateless guards.

Let's examine the various parts of cutter bars.

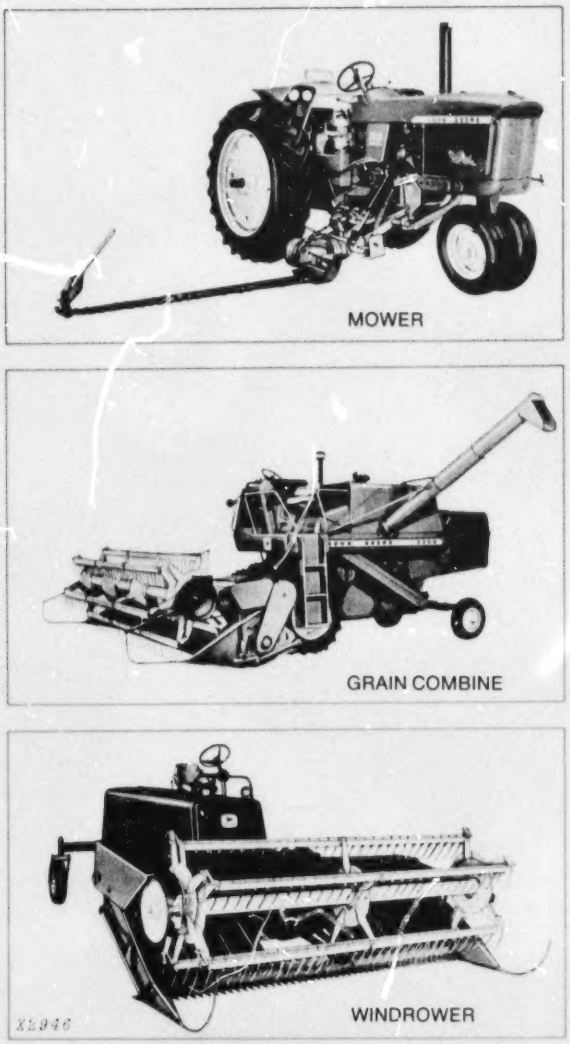

Fig. 4 — Types Of Cutter Bars

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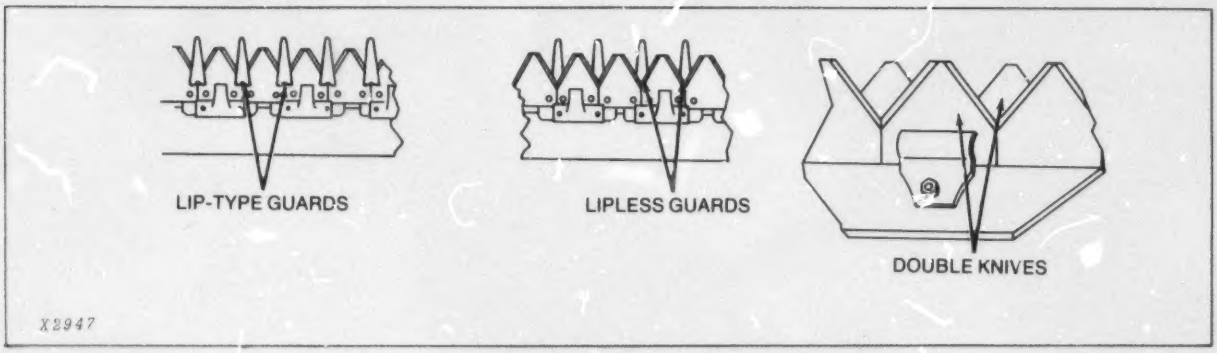

Fig. 5 — Various Types Of Cutter Bars

CUTTER BAR COMPONENTS

All cutter bars have the same basic components and design (Fig. 6). Each part, however, has a special job to perform. A variety of designs are available to deal with specific problems.

DRIVES

We are not concerned at this time with the complete mower. However, to understand how a cutter bar **drive** works, refer to "Special Drives" in the FOS Manual — *Power Trains*.

Drives are either **pitman** or **pitmanless** types. The pitman-type drive knife speed is between 1600 and 2000 strokes per minute. The pitmanless-type drive knife speed is between 1800 and 2200 strokes per minute. A pitmanless-type drive has a faster stroke speed because less vibration is created with these drives.

BAR, INNER AND OUTER SHOES

The **bar** is the frame for all the components of a cutting unit (Fig. 6).

The **inner shoe** and the **outer shoe** are the gauging mechanisms. They support the subsoles which skid over the ground and hold the cutter bar off the ground at the desired cutting height.

Self-propelled windrowers may have adjustable gauge shoes, gauge wheels, or rollers located at each end of the platform to determine the cutting height. Other cutter bar machines have similar skid shoes.

KNIFE

The knife is one of the most important parts of a cutter bar. It consists of the head, knife back, and sections. If the knife is sharp and properly adjusted, it will do a good job.

The **knife head** is located at the driven end of the knife and is the connecting point between the knife and the drive (Fig. 6).

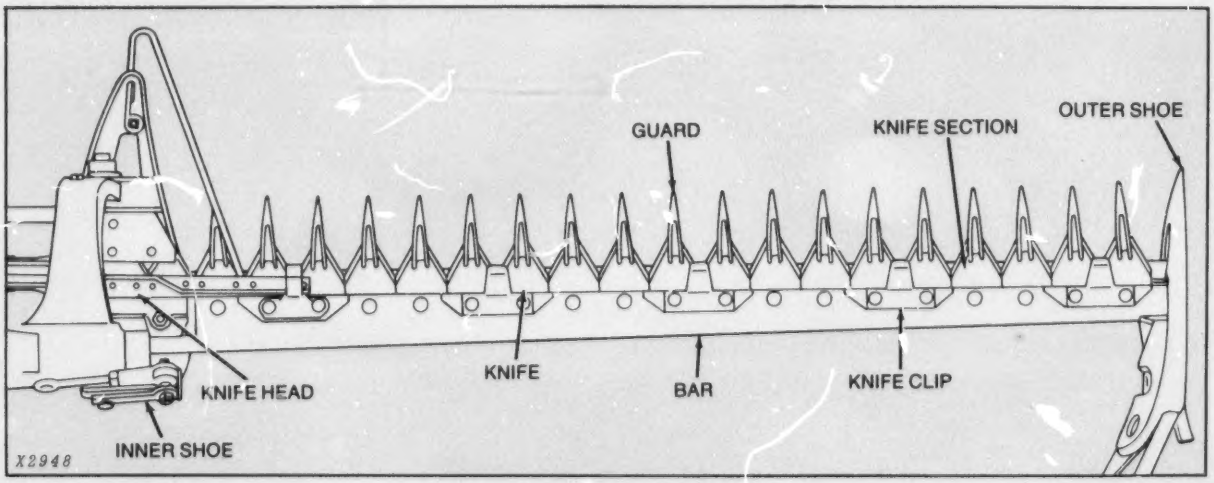

Fig. 6 — Typical Mower Cutter Bar

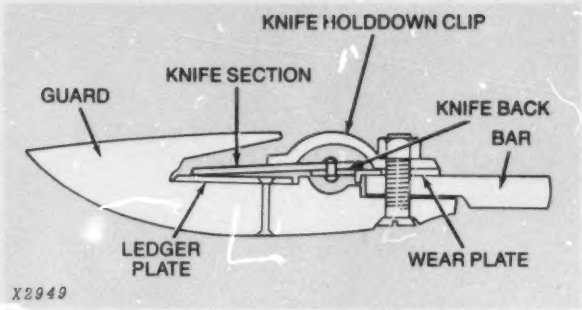

Fig. 7 — Relative Position Of Knife To Other Parts Of The Cutter Bar

The **knife back** (Fig. 7) is a flat strip to which the sections are riveted.

A **section** (Fig. 8) is an individual cutting unit. Four types of sections are available:

- **Smooth**
- **Top-serrated**
- **Bottom-serrated**
- **Armored**

The type of sections used depends on the crop they are to cut.

SMOOTH SECTIONS are used in crops that are fine stemmed and prone to crop buildup from juices that are released during the cutting operation. Chromed sections shed material buildup easier than plain ones.

TOP-SERRATED SECTIONS are used in coarse crops, such as straw, alfalfa, clover, timothy or other crops which have a stiff stem. The serrations have a crop-holding tendency, which helps eliminate the stems from pushing out in front of the section as it moves back and forth. This section will retain its cutting ability without sharpening. Chrome surfacing provides a slick surface that will shed material buildup from crop juices. These sections are widely used on self-propelled units where the cutter bar is off the ground and not near fine dirt.

BOTTOM-SERRATED SECTIONS are used for the same conditions as top-serrated sections. The serrations are on the bottom of the section, so they can be sharpened when the edge becomes dull.

ARMORED SECTIONS (not shown) are coated on the underside with tungsten carbide. They will stay sharp longer than regular sections and can be used in all conditions where serrated sections are used; also in some conditions in place of smooth sections.

GUARDS

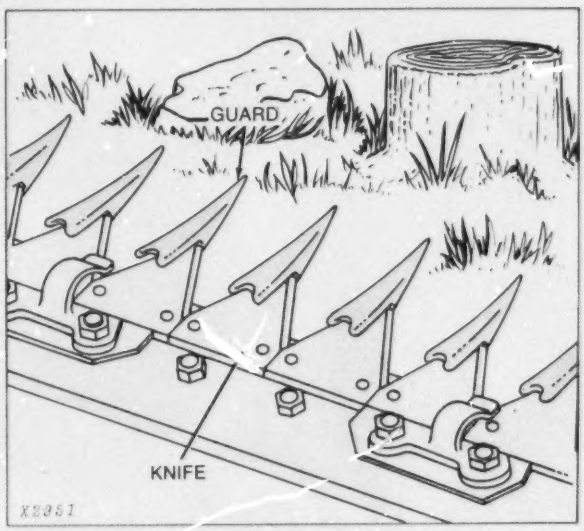

Fig. 9 — Guards Protect The Knife Sections

The **guards** (Fig. 9) protect the knife and act as a stationary shearing edge for the moving section. Guards also divide the plants and guide them into the sections for easy cutting.

Different designs are available for special jobs. The type of crop or existing conditions determine the proper guard to be used.

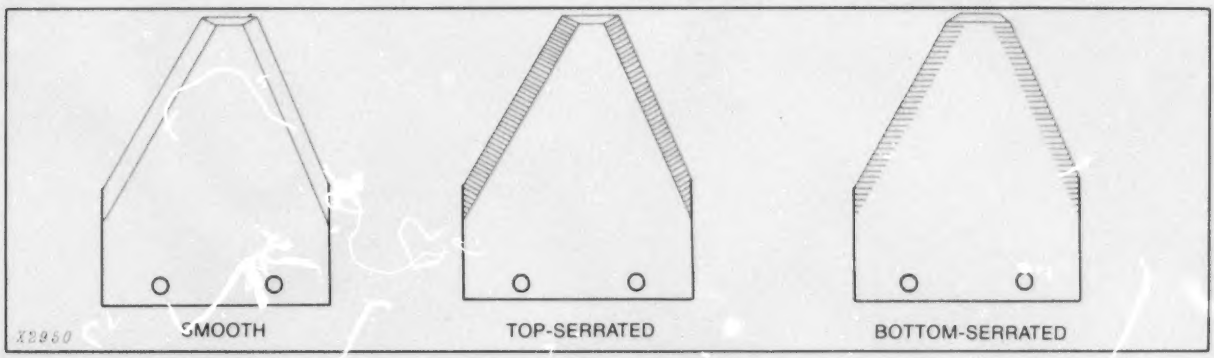

Fig. 8 — Three Types Of Knife Sections

Types Of Guards

The major types of guards are:

- **Rock guards**
- **Regular guards**
- **Lipless guards**
- **Two-tined guards**

Let's take a closer look at these guards (Fig. 10).

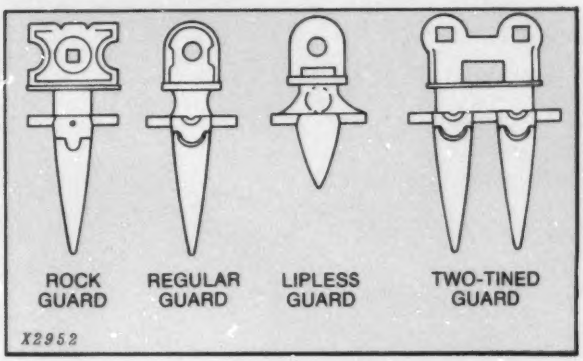

Fig. 10 — Major Types Of Guards

Rock Guards, usually found on mowers, are extra-heavy-duty and designed to take the abuse of rough stony ground. They have 3-inch spacing from the mid-point of one to the mid-point of another and are made of either steel or malleable iron.

Regular Guards, used on mowers or self-propelled machines, are similar in design to the rock guard except that they are not as strong and made of malleable iron. They also have 3-inch spacing from the mid-point of one to the mid-point of the next.

Lipless Guards are a special-purpose guard, where crop penetration is a severe problem. The section rides on top of the guard and cuts the material with less choking.

Two-Tined Guards are becoming very popular because they mount in pairs and are thus cheaper. They have a low profile and a slim design, giving good penetration. These guards are more commonly used on self-propelled machines but are rapidly gaining popularity on mower cutter bars where stones are not a problem.

A **ledger plate** (Fig. 7) is the cutting part of a guard and can have either smooth or serrated edges. There are two methods for securing the ledger plate to the guard. One method is by riveting and the second is by snapping the plate into position. Two-tined guards do not have ledger plates. The surface on which the section rides is machined and has sharp cutting edges.

WEAR PLATES AND KNIFE CLIPS

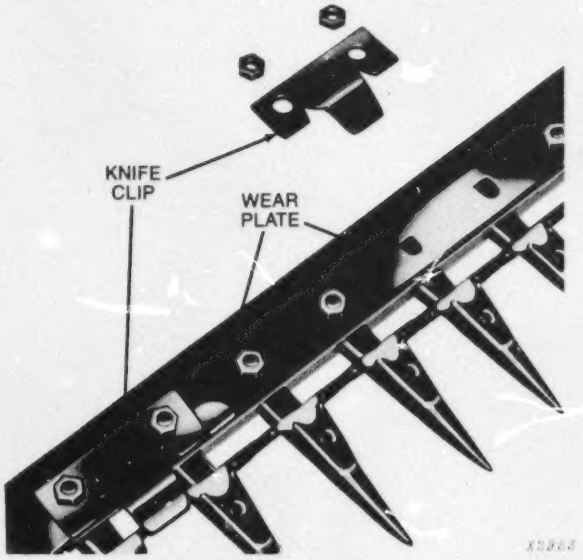

Fig. 11 — Wear Plates And Knife Clips

Wear plates (Fig. 11) act as guides for the knife back. They keep the knife back in proper position in relation to the ledger plates so a shearing action can be maintained. As they wear, they can be adjusted at their slotted mounting holes.

The **knife hold-down clips** (Fig. 11) hold the knife snugly against the ledger plates for clean cutting.

MAINTENANCE AND ADJUSTMENT

The care and adjustment of a cutter bar is essential to good cutting. Remember, no matter how well a cutter bar is designed, it will operate only as well as it is adjusted and maintained.

The keys to good cutter bar operation are:

1. **Maintenance**
2. **Adjustment**

Let's study them more closely.

MAINTENANCE OF THE CUTTER BAR

The components which support the action of the knife and guards while cutting include the wear plates, knife hold-down clips, knife-head guide plates, and drives. These parts must all be maintained properly if good operation is expected.

The knife, of course, must be kept sharp to shear rather than tear off the material being cut. The guards must be kept in alignment with the knife so that the shearing action takes place at each guard.

Wear plates, knife hold-down clips, and knife-head guides must be kept in adjustment as they wear or poor cutting performance will result. Excessive play caused by too much wear on these parts will increase the wear rate.

On mowers, proper lead angle for the cutter bar is important in reducing wear on the knife head. Also, for a good knife cut, the cutter bar must be at right angles to the forward direction of travel.

Poor maintenance of these parts can cause plugging, rob horsepower from the machine, and slow the mowing speed.

If the drive mechanisms of the mower are not serviced at the recommended intervals, the bearings, belts, chains, or gears may fail at critical times.

Now that we have described the need for maintenance, let's examine *adjustment* of the cutter bar.

ADJUSTMENT OF THE CUTTER BAR

Adjustment of the cutter bar usually involves more than one step; making one adjustment may require that another be made. For example, when wear plates require adjustment, knife hold-down clips and knife-head guides will probably need checking.

Complete cutter bar adjustment includes the following jobs:

1. **Adjusting the Knife:**
   - *a. Register*
   - *b. Head Guides*
   - *c. Wear Plates*
   - *d. Hold-Down Clips*
2. **Adjusting the Guards**
3. **Adjusting the Cutter Bar Lead**
4. **Adjusting the Operating Height:**
   - *a. Shoes*
   - *b. Flotation*
5. **Adjusting the Cutter Bar Tilt**

Let's examine each adjustment in detail.

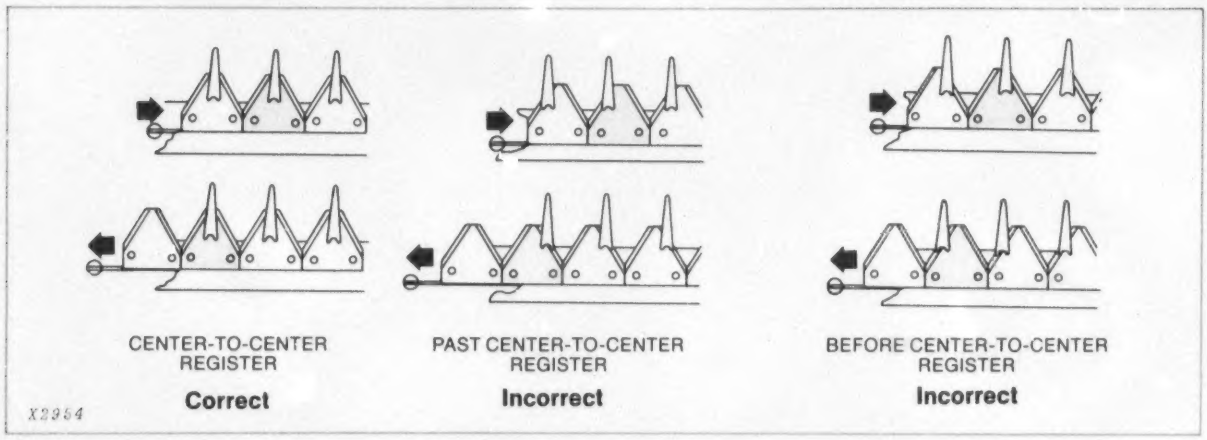

Fig. 12 — Three Types Of Knife Register

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ADJUSTING THE KNIFE

A sharp knife, properly adjusted, is the key to efficient mowing. The knife must run smoothly in the cutter bar. (If the knife cannot be moved by hand, it is binding.) Each section should be sharp and riveted tightly to the knife back.

Checking Knife Register

Knife register is an important adjustment for smooth cutting and minimum side draft. Normally it is changed only when the pitman is damaged or replaced, or the cutter bar lead is changed.

Most pitmanless drive cutter bars automatically remain in register because the reciprocating mechanisms are mounted on the cutter bar. The stroke remains the same, so the register does not change.

To check the register, be sure the drive mechanism is attached to the knife and the cutter bar is level and in cutting position. Rotate the drive by hand and at the outer and inner ends of the stroke, note the position of the knife sections in relation to the guards.

The knife is in register if at the end of each stroke the knife sections are at *equal distance* from the center line of the guards as shown in Fig. 12 on the facing page.

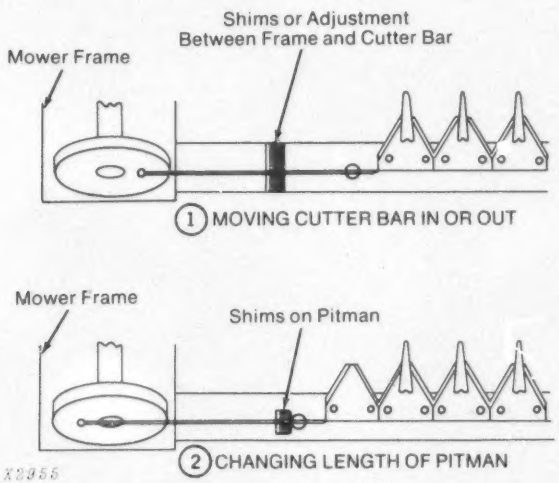


Fig. 13 — Two Methods Of Adjusting Knife Register

The method of adjusting knife register varies with each kind of mower. Basically, however, you must either move the cutter bar in or out, or change the length of the pitman (Fig. 13).

Adjusting Knife Head Guides

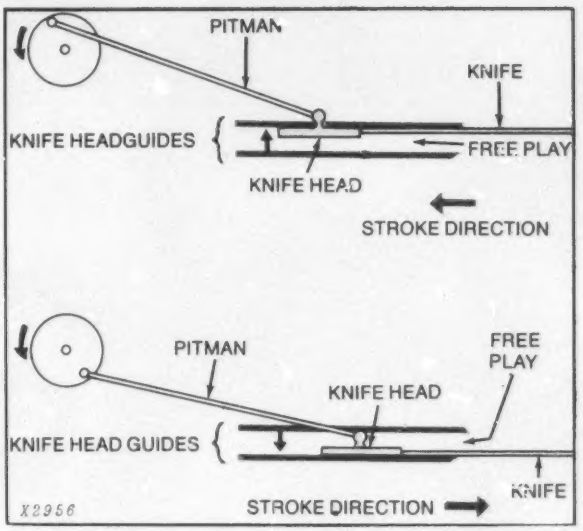


Fig. 14 — Excessive Vertical Play

When the cutter bar is in operation, the *knife head* will slap or hammer if it is not in proper adjustment. This slapping problem is caused by excessive vertical play due to wear of the knife head guides (Fig. 14). Pitman type drives are more apt to do this than pitmanless drives because of their design.

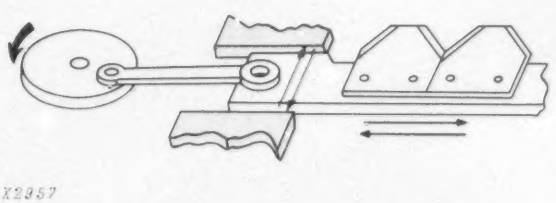


Fig. 15 — Excessive Side Play

Some pitmanless drives have side play and must be adjusted to compensate for wear (Fig. 15).

To check for wear on the knife head guides, grasp the knife head and move it up and down and from side to side. If an unusual amount of play exists, adjust as necessary. Most knife head guides are adjusted by adding or subtracting shims (Fig. 16). The amount of vertical clearance is stated in the machine operator's manual. Use a thickness gauge for accurate spacing. If too much clearance exists, remove shims.

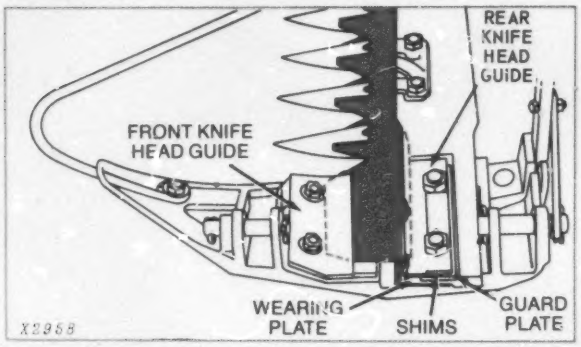


Fig. 16 — Knife Head Guide Adjustment

Adjusting Wear Plates

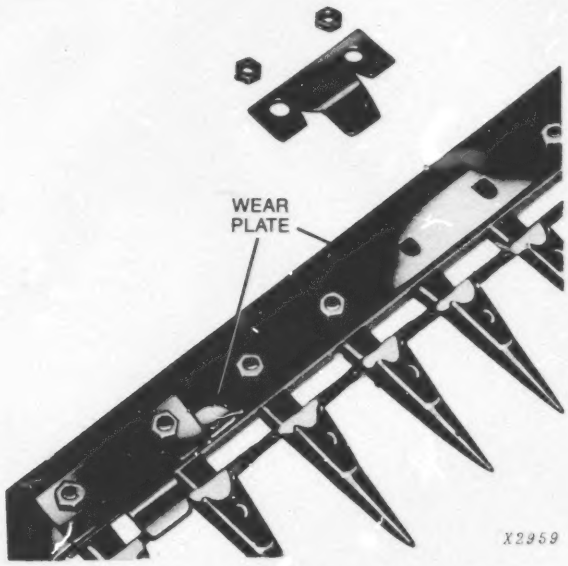


Fig. 17 — Wear Plate And Knife

Wear plates act as guides for the knife back (Fig. 17). They support the knife back to maintain a shearing action between the ledger plates and the knife sections.

Excessive play, caused by too much wear between the knife back and the wear plates, will allow vibration and cause faster wear on other parts of the cutter bar.

As the wear occurs, move the wear plates forward. *Do not adjust the wear plate too close.* Slotted holes in the plates allow for this adjustment.

Adjusting Hold-Down Clips

Knife hold-down clips hold the knife close to the ledger plates (Fig. 17). This insures close contact between the cutting edge of the knife and the edge of the ledger plate. *If the hold-down clip holds the knife too loosely*, ragged cutting and choking will result. *If it is too tight*, the knife will bind.

Most manufacturers prefer to have the knife tilted slightly so there is minimum clearance between the front of the ledger plates and the knife section tips. This insures a positive contact between the ledger plate and the knife section at the point of shear. It gives a more positive cutting action and reduces draft. This calls for approximately a 1/32-inch clearance between the rear of the ledger plate and the rear of the knife section. Others have no clearance — the knife lies flat on the ledger plate.

There are two ways of adjusting hold-down clips:

(1) Add or remove spacers to increase or reduce clearance between the clip and the knife section.

Fig. 18 — Setting Knife Clip Down

(2) The second method involves clips that are not mounted with spacers and must be adjusted with a hammer. To reduce clearance, strike the clip on the top with a two-pound hammer to bend it downward (Fig. 18).

Fig. 19 — Loosening Knife Clip

To increase clearance, strike clip on the flat surface at the rear of the clip (Fig. 19).

ADJUSTING THE GUARDS

The guards protect knife sections and hold the ledger plates. They also act as dividers and comb through the crop, separating the plants and guiding them into the knife. For these reasons, guard points should be sharp, smooth, and aligned. Guard maintenance can be divided into three areas:

1. *Checking the condition of the guards.*
2. *Aligning the guards.*
3. *Adjusting the guard lip clearance.*

Let's look at each adjustment in detail.

Checking Condition Of Guards

Checking the condition of the guards can be done while they are mounted on the cutter bar. Inspect each one for wear, nicks, breakage, rust, and bending. All these things can cause improper operation. Use a file to remove rust, nicks, and to sharpen the guard points. If this cannot be done, replace the damaged guard. Inspect the ledger plates and replace if dull or broken. Tighten all plates to maintain the opposing shearing force to the cutting edges of the knife sections.

Aligning The Guards

Check for any guards that are too high. Do not attempt to adjust the majority of the guards upward to align with a few that are too high.

When aligning the points of the guards, be sure the cutter bar is held rigid by the platform frame (windrowers) or the inner shoe and drive unit (mowers). Otherwise, any guard alignment has been done in vain.

Some guards are made of cast malleable iron and others are made of forged steel. Forged steel guards are less likely to nick, bend, or dull in stony conditions.

Straighten and realign guards of either material with a hammer and smooth with a file.

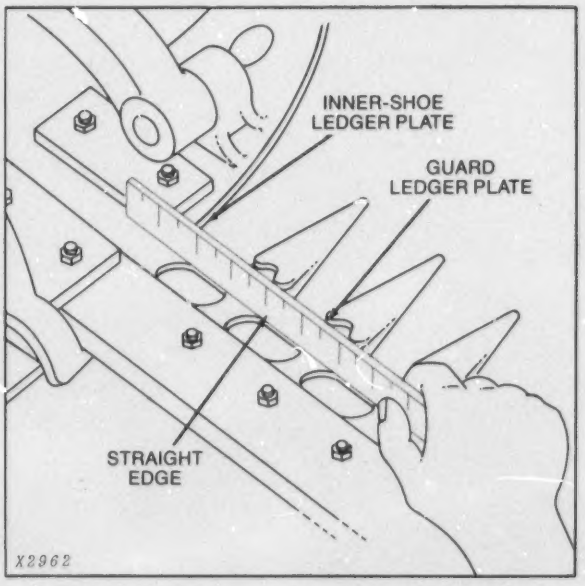
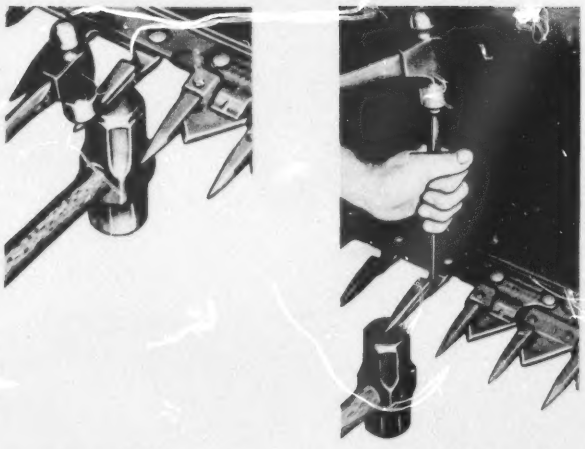


Fig. 20 — Checking Guard Alignment (Mower Shown)

For mowers, line up the first guard with the inner shoe ledger plate. Use a straight edge (Fig. 20).

If the guard needs to be raised, bend it up with a hammer. Strike the guard in the thickest area, usually just ahead of the ledger plate.

Disregard the position of the guard points; the guard ledger plates must be in line.



SETTING GUARD DOWN SETTING GUARD UP

X2363

Fig. 21 — Setting Guards Down (Mower Shown)

If the guard must be lowered, hold a heavy hammer under the base of the guard to help steady the blows (Fig. 21). Pound in front of the ledger plate. Be careful not to bend the guard lip.

Perform the same procedure at the outer shoe. After the guards have been aligned at both ends, sight down the cutter bar and bend any of the other guards which are out of adjustment.

NOTE: Special guard adjusting tools are also available for aligning guards.

Aligning the guards on a combine, forage harvester, or windrower presents a slightly different situation. There is no inner and outer shoe as on mowers. Therefore, the starting point is at the driven end of the knife. Align the first two or three guards to allow the knife head minimum friction or binding on the guards as it moves back and forth. Then align the rest of the guards by sighting down the length of the cutter bar. (On long knives it is virtually impossible to get it absolutely straight. A slight, gradual "droop" will do no harm.)

Adjusting Guard Lip Clearance

Adjusting the guard lip clearance is the final step in guard maintenance. Sometimes aligning the guards will change the guard lip clearance; this is the reason for doing this adjustment last. Hold the clearance between the rear of the guard lip and the knife at approximately ⅜ to ½-inch (Fig. 22). Too small a clearance will create plugging and binding of the material because it cannot pass through after it has been cut. Too much clearance will leave the knife unprotected. (On guards with no ledger plate, the clearance at the back of the lip should be 1/32 to ⅛ inch more than at the front.)

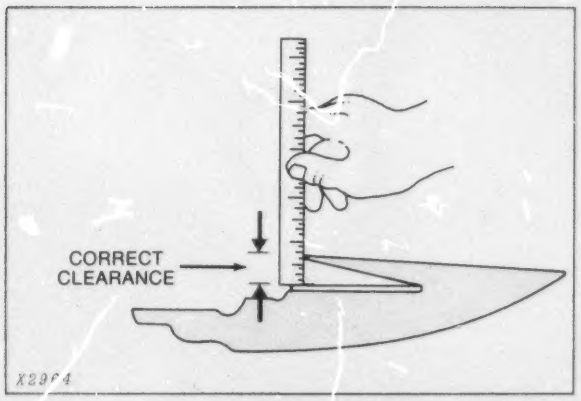


Fig. 22 — Checking Guard for Lip Clearance

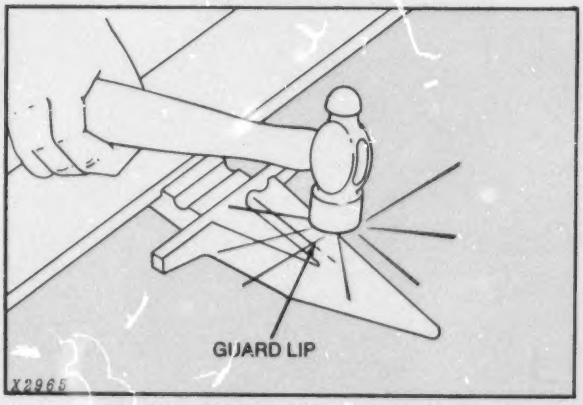


Fig. 23 — Reducing Guard Lip Clearance

To decrease clearance, tap lightly on the lip with a hammer (Fig. 23).

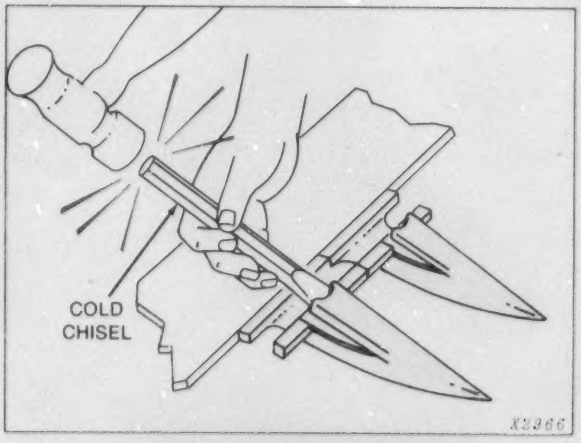


Fig. 24 — Increasing Guard Lip Clearance

To increase clearance, use a chisel as a wedge (Fig. 24). Be careful, as overbending can break the guard lip.

ADJUSTING CUTTER BAR LEAD (MOWERS ONLY)

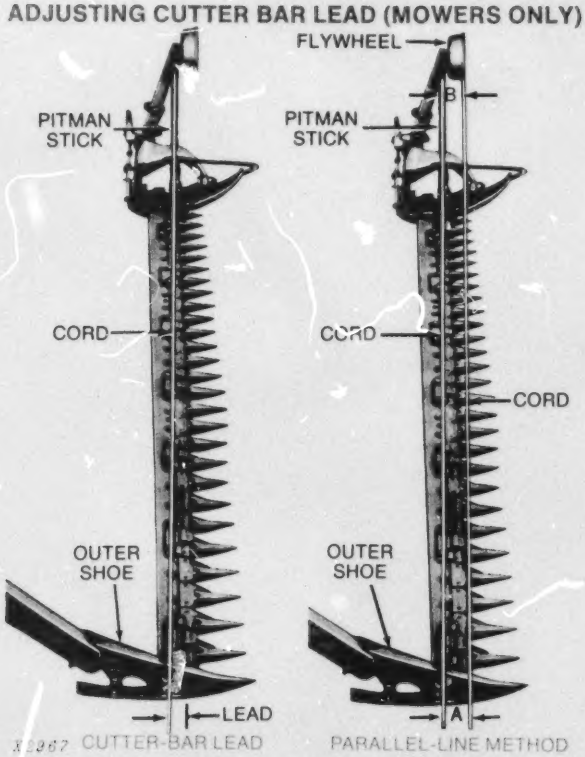


Fig. 25 — Cutter Bar Lead

Cutter bar lead applies only to cutter bar **mowers**. Combines, forage harvesters, and windrowers do not have this adjustment because the platform stabilizes the cutter bar and will not allow one end to lag behind the other while cutting.

However, mowers have only one end of the cutter bar connected to a solid object. For this reason, when the mower is not in operation, the outer end should be ahead of the inner end of the cutter bar (Fig. 25). This is called **cutter bar lead**. Cutter bar lead is divided into **primary lead** and **secondary lead**.

Primary Lead

When mowing, the pressure of the plants against the cutter bar pushes the outer end back until the cutter bar is at right angles to the forward motion. This is called *primary lead*.

Secondary Lead

When operating, the pitman must be at right angles to the line of travel of the mower. This is called *secondary lead*.

Adjustment

Normal wear will cause the cutter bar lead to decrease until it needs adjustment. To check and adjust, proceed as follows:

1. Place tractor and mower on a level surface.
2. Be sure cutter bar is flat on the ground.
3. Pull outer end of cutter bar backward by hand to take up any slack.
4. Find a guideline from which you can measure the lead (Fig. 25).

The guideline should be at right angles to the forward motion of the mower, and parallel to the pitman on pitman mowers.

One of two basic methods for establishing a guideline is called **parallel-line method** (Fig. 25). Stretch a cord from the pitman bearing across the cutter bar while making sure that the cord is parallel with the pitman. Secure the cord at both ends.

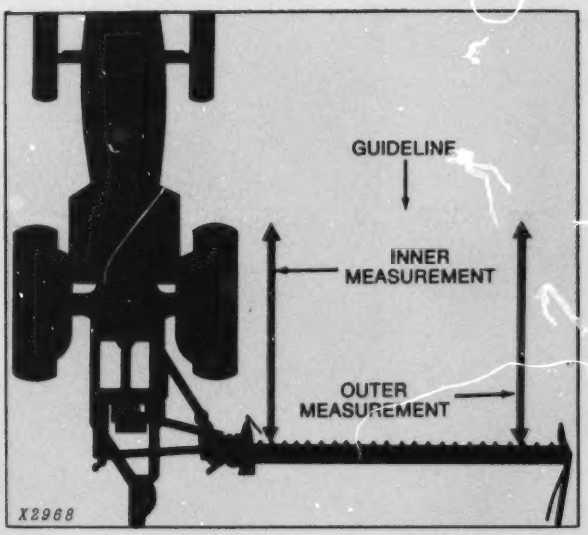


Fig. 26 — Straight-Board Method

The second is called **straight-board method**. Place a 2" x 4" straight board in front of the rear tires of the tractor as shown in Fig. 26. Secure the board so it cannot be moved. Measure from the board guideline back to the knife section rivets.

The distance from the outer end of the cutter bar should be *shorter* than that at the inner end, measured from the guideline. The amount varies depending on the length of the cutter bar and the manufacturer's recommendation. The normal range is ¼-inch per foot of cutter bar. The longer the cutter bar, the more lead is necessary.

Next adjust the cutter bar primary and secondary lead. Three methods are most common:

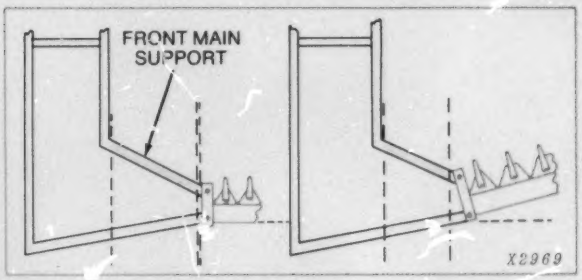


Fig. 27 — Shortening Front Support

1. Shorten the front main cutter bar support (Fig. 27).

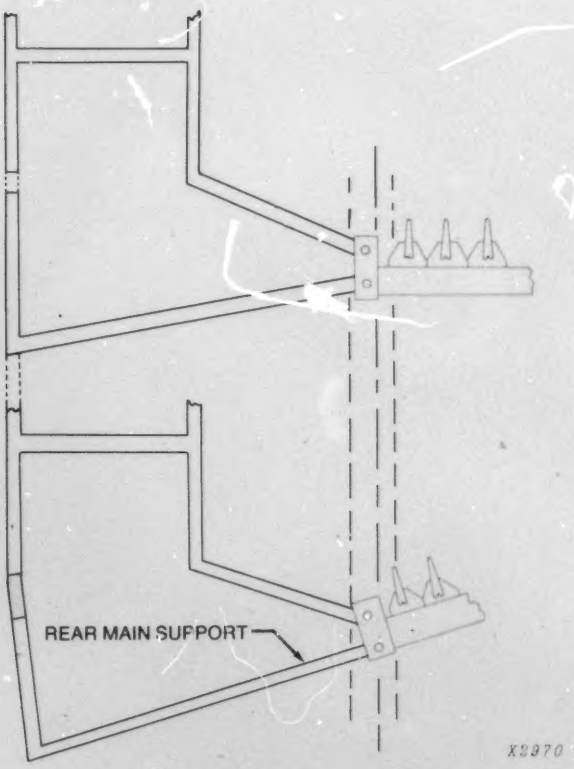


Fig. 28 — Lengthening Rear Support

2. Lengthen the rear main cutter bar support (Fig. 28).

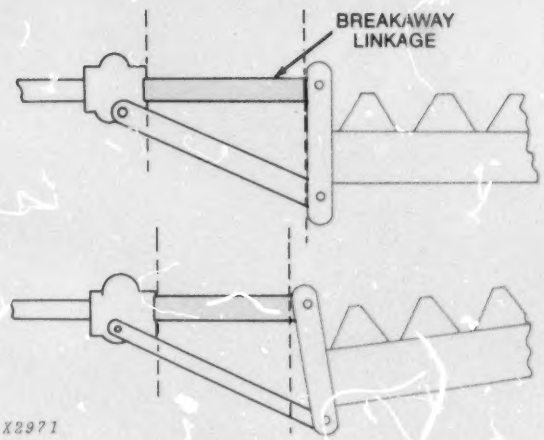


Fig. 29 — Shortening Length Of Breakaway Linkage

3. Shorten the length between breakaway linkage and clamps (Fig. 29).

Select the method used for your mower and make the necessary adjustment.

ADJUSTING THE OPERATING HEIGHT

Height of cut depends on the type of crop and ground conditions. In stony conditions, a longer length of cut would be best to minimize cutter bar damage. If the ground is smooth and rock-free, a shorter length of cut is possible.

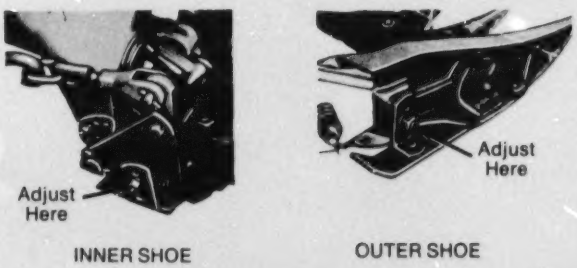


Fig. 30 — Mowing Height Adjustment For Mower

Mowers have adjustable runners on their shoes (Fig. 30) which provide the height adjustment. Relocate the bolts into the desired holes to set the cutter bar height.

Windrowers have adjustable shoes, rollers, or wheels to determine cutter bar height (Fig. 31). The shoes on the platform of the windrower are adjusted in the same manner as the runners are on the mower.

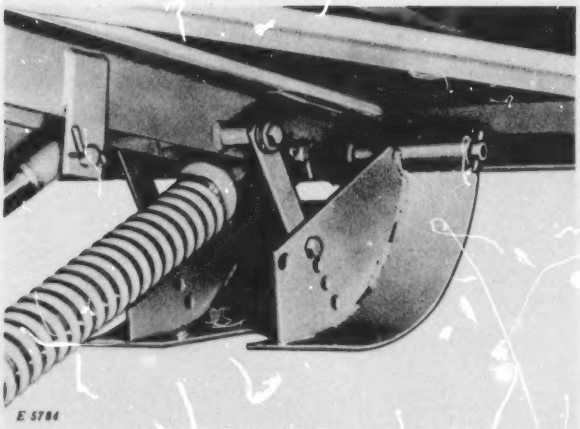


Fig. 31 — Windrower Gauge Shoe

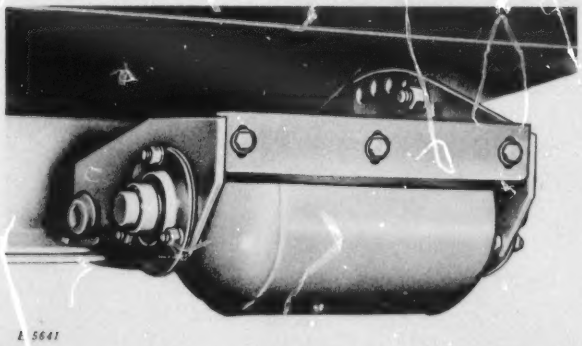


Fig. 32 — Gauge Roller

Gauge wheels or rollers (Fig. 32) replace the shoes on some platforms and are adjusted in the same way.

Closely related to height of cut is cutter bar *flotation*. The cutter bar float spring (Fig. 33) should be adjusted so that the cutter bar will follow the ground contour to enable it to do a good job of cutting at all times. Too much flotation will cause the bar to bounce, leaving good material uncut. Too little flotation will allow the bar to ride too heavily on the ground, causing excessive guard and knife damage. For exact adjustment, see the operator's manual.

ADJUSTING THE CUTTER BAR TILT

Cutter bar tilt is vital to a good job of cutting. **Tilt** refers to the angle of the cutter bar in relation to the ground. This tilt is adjustable by means of a lever (Fig. 34) or other device. The ideal angle is parallel to the ground but often this is impractical due to crop or ground conditions.

Mowers usually have an 8 to 10 degree upward and 8 to 10 degree downward tilt range. When the crop is down or tangled, a downward tilt is recommended so the guard points can penetrate and lift the crop for proper cutting.

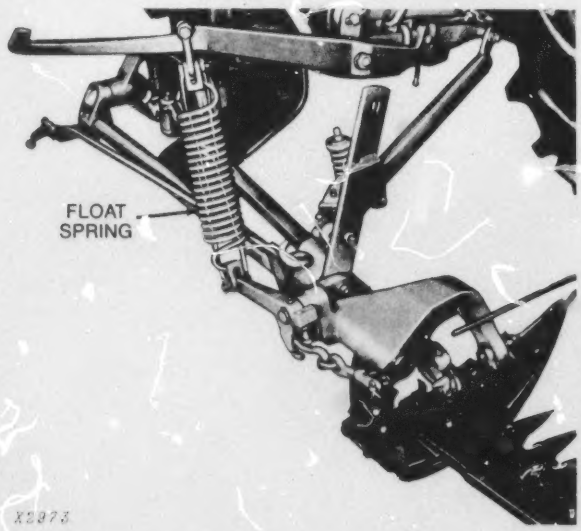


Fig. 33 — Cutter Bar Float Spring

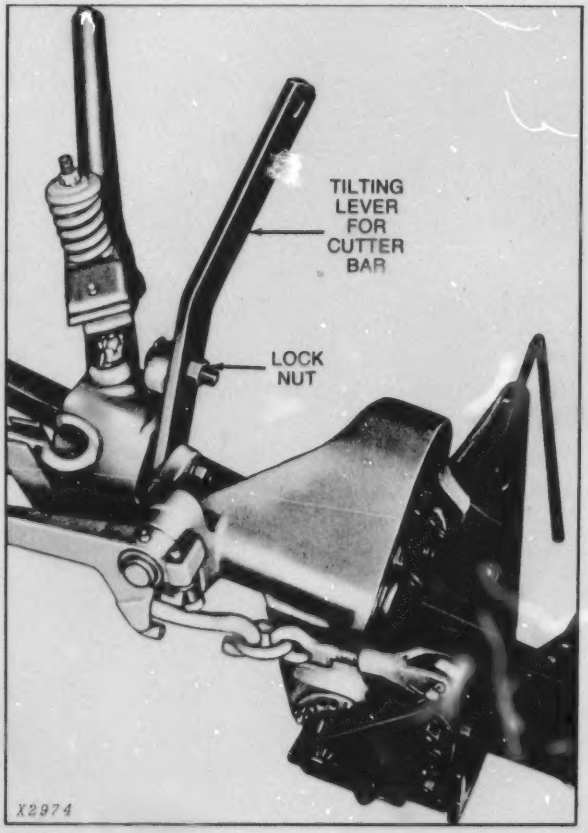


Fig. 34 — Cutter Bar Tilt Adjustment

Tilting the cutter bar downward increases the possibility of guard and knife damage because they are closer to the ground. In stony, rough conditions, upward tilting is recommended because it raises the guard points and lessens possible damage to the cutter bar.

Windrowers and combines have a different cutter bar adjustment, but the tilt principle remains the same. It is difficult to change the cutter bar angle because it is an integral part of the platform. Therefore, the only way the tilt can be changed is by moving the entire platform. Most windrowers have a downward tilt built into the cutter bar so they can cut the crop short in all types of conditions.

If adjustment will not correct any problems found in cutter bar operation, the defective parts must be repaired or replaced. Let's examine this aspect of service.

REPAIR AND REPLACEMENT

The decision on when and how to replace parts can be a problem unless you have a good knowledge of cutter bar repair. This section will explain how to make repairs and when to replace worn or damaged parts.

SERVICING THE KNIFE

The knife sections must be sharp; if not, they should be sharpened or replaced. Damaged sections must also be replaced. In addition, the knife back must be straight; if not, excessive wear on parts or binding will result.

To service the knife, it must be removed from the cutter bar. It is true that some repair or replacement can be made while the knife is in the cutter bar, but this is not recommended.

REMOVING THE KNIFE

Removal of the knife is a relatively easy job, but be careful at all times. You can easily lose a finger by careless handling of cutter bar knives. For easy handling, oil the knife and run it back and forth for a minute to loosen any rust deposits. If the knife is gummed up, spray water over it while the knife is running.

Then block the cutter bar up with wooden blocks for easier access to the knife (Fig. 35).

Fig. 35 — Blocking Up The Cutter Bar

Next, remove the connector from the knife head. Three types of connectors are common: pin-type, bolt-type, and spring-loaded type.

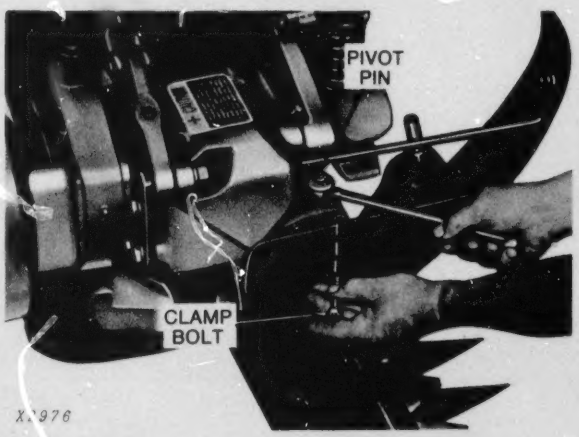


Fig. 36 — Pin-Type Connector

On *pin-types*, remove clamp cap screws and then pull the pin from the knife head (Fig. 36).

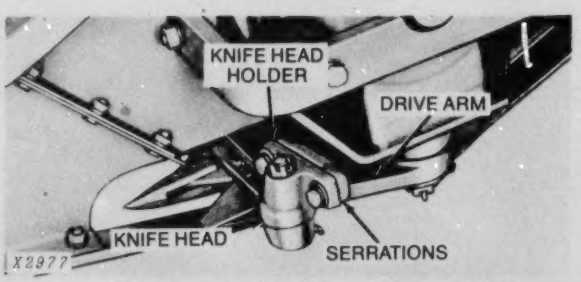


Fig. 37 — Bolt-Type Connector

On *bolt-types*, remove cap screws attaching knife-nead holder (Fig. 37) to drive arm.

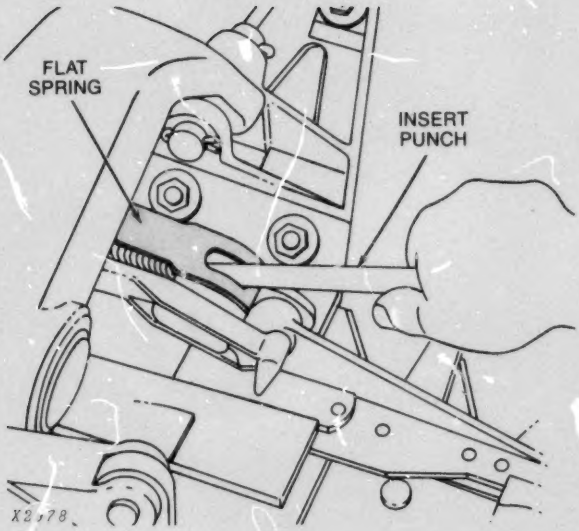


Fig. 38 — Spring-Loaded Connector

On *spring-loaded types*, insert a punch in the hole of the flat spring (Fig. 38). Force the plunger back and then push the flat spring down between the pitman straps to free the knife head.

The final step is pulling the knife out by hand.

CAUTION: If the sections hang up on the ledger plates, maneuver them with a wooden block — not your fingers.

Grasp the knife on its back side away from the knife sections using *both hands*. This will avoid placing your fingers in a vulnerable position.

REPAIRING THE KNIFE

Straightening the knife is easy if it is not bent severely. Remove the knife as described above and lay it on a smooth, flat surface. Sight along the edges to determine where it is bent. If it is crooked, clamp the knife in a vise and straighten it by careful bending.

Knife sections can be *sharpened* with good results if done properly. (Overserrated sections cannot be sharpened satisfactorily; they must be replaced when dull or broken.) Take special care while grinding sections.

For best results, use a special sickle-grinding wheel (Fig. 39) of medium coarse (30 to 60 grit size). It will grind the original bevel on the sections more easily.

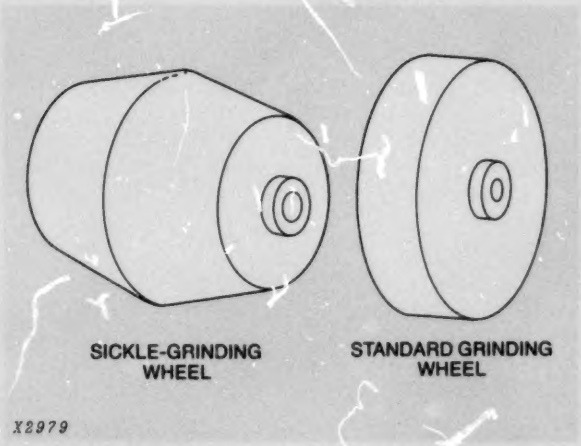


Fig. 39 — Grinding Wheels

A standard grinding wheel can be used but it is very easy to grind the wrong bevel onto the sections. The same holds true for a hand file.

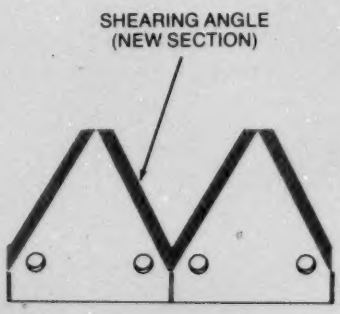


Fig. 40 — Original Shear Angle And Bevel

Keep the shearing angle of the section the same as the original edge appeared. The face of the bevel should be approximately ¼-inch wide (Fig. 40).

When sections have been ground EXTENSIVELY (Fig. 41) replace them because they no longer have a heat-treated surface, and wear occurs very rapidly. **Do not overheat the section when grinding.** Most sections have a hardened edge to help hold a sharp edge. Repeated or improper sharpening will grind away the hardened edge and rapid wear will occur.

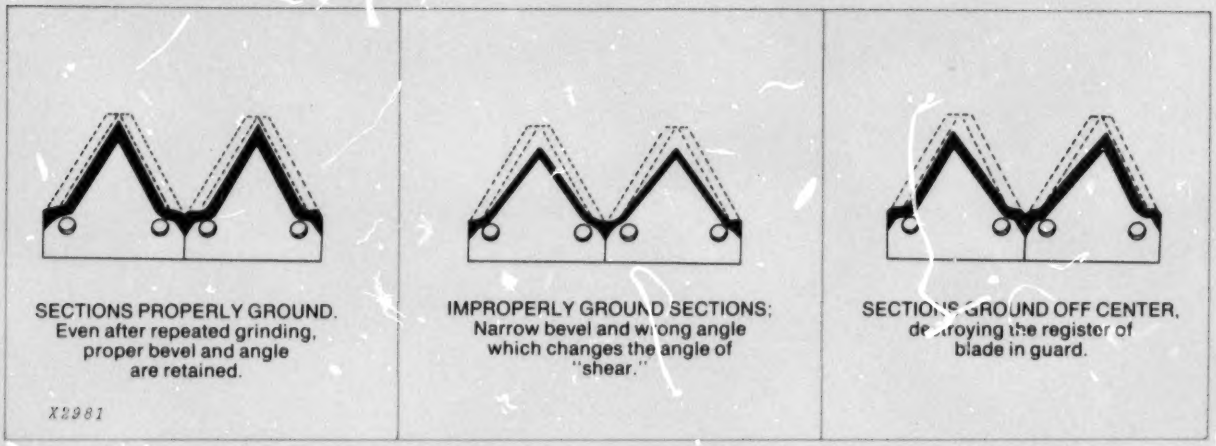

SECTIONS PROPERLY GROUND.
Even after repeated grinding, proper bevel and angle are retained.
X2981
IMPROPERLY GROUND SECTIONS;
Narrow bevel and wrong angle which changes the angle of "shear."
SECTIONS GROUND OFF CENTER,
destroying the register of blade in guard.

Fig. 41 — Knife Sections That Have Been Sharpened Several Times

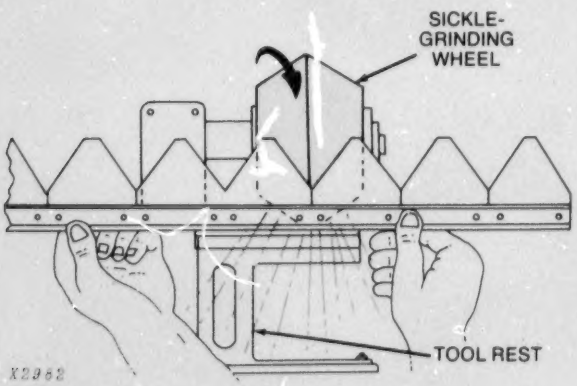


Fig. 42 — Correct Grinding Method

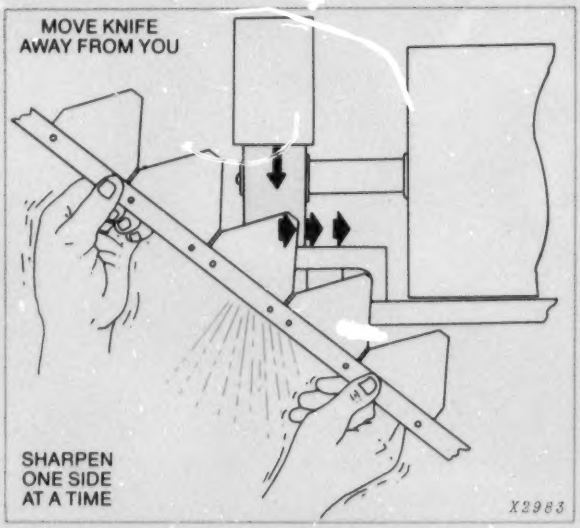


Fig. 43 — Using Standard-Type Grinding Wheel

If you are using a beveled sickle grinding wheel, hold the knife assembly in both hands and place it lightly on top of the wheel (Fig. 42). The knife back should rest on a stable, flat surface for easy control. The grinding wheel should turn against the edges of the sections so feathering will not occur.

If you must use a standard grinding wheel, sharpen one side of the section at a time (Fig. 43). Use only the curved face of the wheel and not the sides. Move the knife away from you as you sharpen.

If the section is broken, replace it. It is possible to replace sections when the knife is in the cutter bar, but a section clamp must be used. The old rivets can be sheared off with a chisel and hammer and the new section and rivets can be replaced by using the clamp. The clamp forms the rivet head.

This method of replacing sections should be used only if a few sections need replacing. When all the sections are to be changed, knife removal is essential and a knife repair block or a vise should be used.

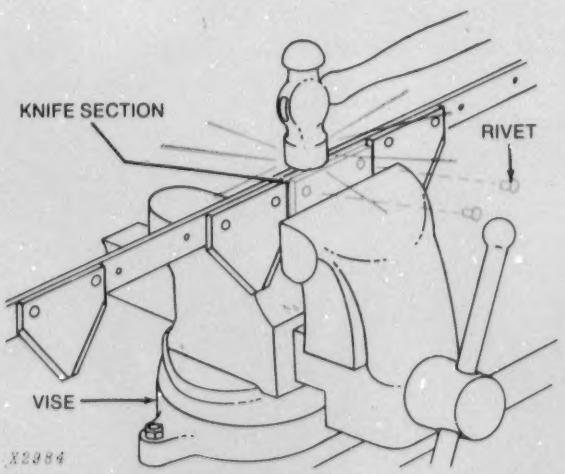


Fig. 44 — Shearing Rivets In A Vise

If using a vise, place the knife tips down between the jaws with the knife back resting on the stationary jaw. The knife should be held loosely so that the section can be driven between the jaws with a two-pound hammer to shear the rivets as shown in Fig. 44.

Replace the sections alternately so that the new sections will remain in proper relationship. After every other section has been replaced, go back and change the rest. This keeps the knife straight and eliminates shifting of rivets when tightening the sections to the knife back.

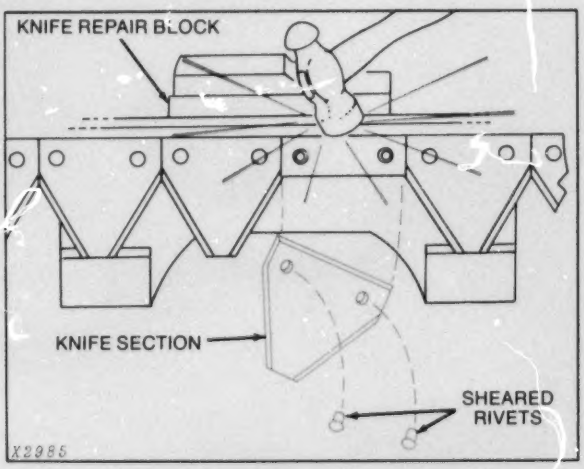


Fig. 45 — Shearing Rivets In A Repair Block

If a knife repair block is to be used, place the knife tips down, in the slot provided (Fig. 45), and replace the sections in alternate order.

Strike the back edge of the section with a 2-pound hammer and shear the rivets off. If the rivets are punched out, there is a good chance of enlarging the holes in the knife back.

To install new sections, you must select the correct rivet size. A rivet should extend 1½ to two times its diameter through the knife section.

Insert two rivets through the knife back and section and place the knife on a riveting block with the bevel side of the section up. Strike the rivet with a rivet setting tool, using firm, direct blows (Fig. 46). This will expand the rivet and make a good head.

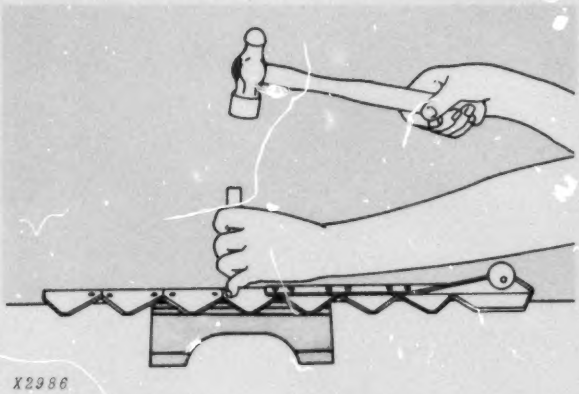


Fig. 46 — Making Rivet Head

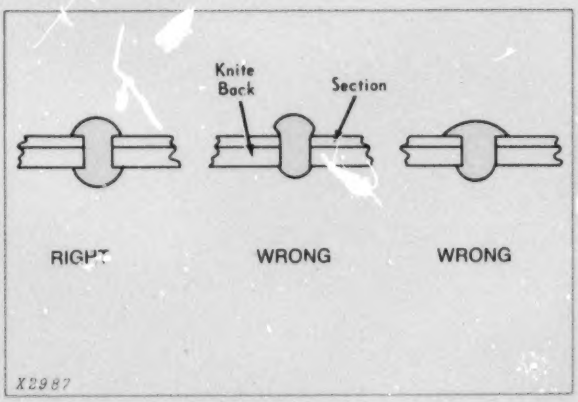


Fig. 47 — Correct And Incorrect Ways To Form Rivets

A rivet that is not properly formed will quickly loosen and fail (Fig. 47).

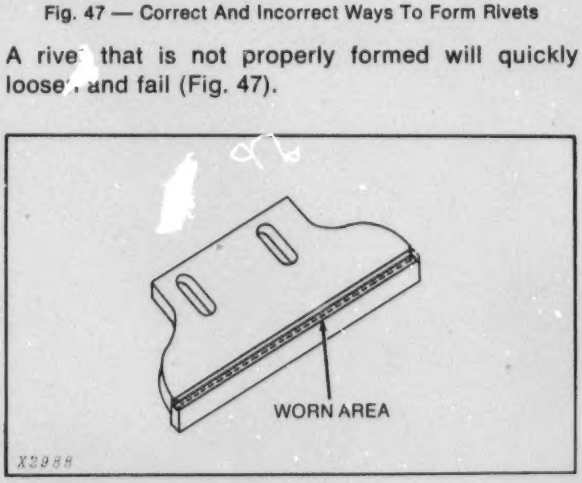


Fig. 48 — Wear Plate Wear Area

Wear plates cannot be repaired. They must be replaced. When the plate wears to one-half its thickness, replace it (Fig. 48).

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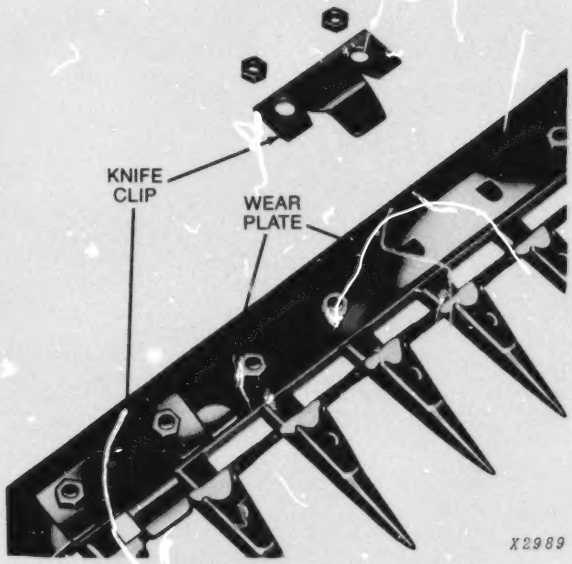

Fig. 49 — Replacing Wear Plate And Knife Clip

Remove the guard nuts, knife hold-down clip, and old wear plate (Fig. 49) and replace with new plate. Adjust the wear plate so that the knife is free in moving through one complete cycle. Tighten the guard nuts.

Replace the *knife hold-down clips* if they cannot be properly adjusted. To remove the clip, remove the guard nuts and change the clip. Tighten the guard nuts.

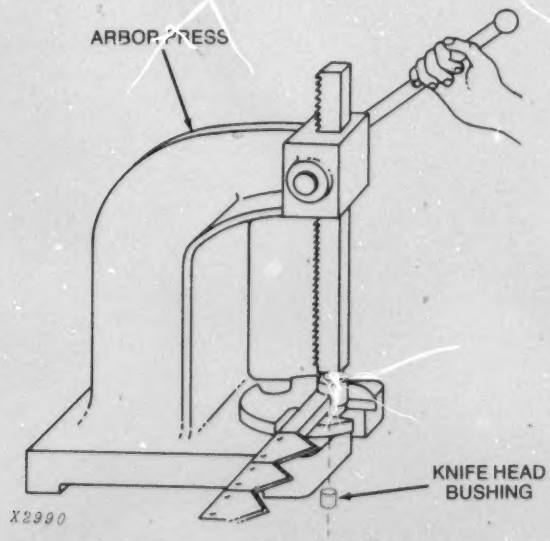

Fig. 50 — Removing A Knife Head Bushing With An Arbor Press

The *knife head* is attached to the drive unit by a pin or shaft. Replace the knife head bushing if it becomes worn. A worn bushing causes excessive vibration and additional wear on other cutter bar parts. The simplest way to check for a worn bushing is to check the play between the pin and bushing.

To replace the bushing, use a press or a punch (Fig. 50). If you are using an arbor press, place a pipe or steel rod, which has the same diameter as the bushing, over the bushing and press it out. Press the new bushing into the knife head in the same manner.

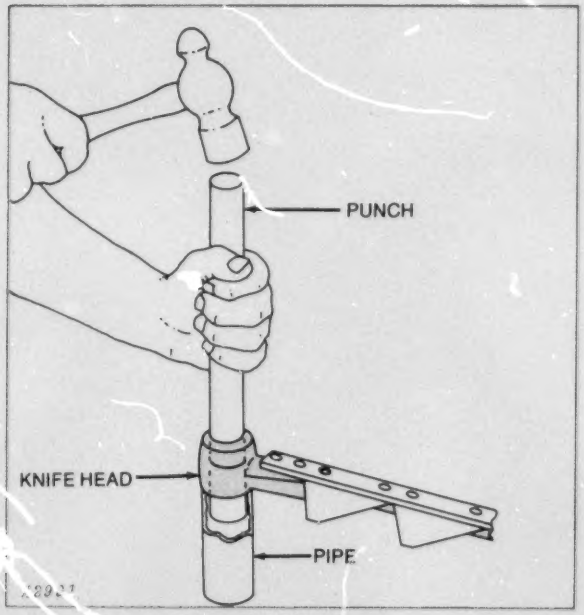

Fig. 51 — Removing A Knife Head Bushing With A Punch

If you are using a punch, position the knife head over the end of a pipe and strike the punch with a hammer to remove the bushing (Fig. 51). Be sure the punch has the same diameter as the bushing. Replace the new bushing in the same manner. Check the pin for wear and replace it if required.

SERVICING THE GUARDS

Once a cutter bar *guard* is broken, it is almost impossible to repair. It must be replaced.

To replace a guard, remove the guard bolt, which may also secure the wear plate and knife hold-down clip (Fig. 52).

If the guard is not broken but is badly bent and nicked, try to straighten the guard. Place a pipe over the point and bend it to its original position. File the nicks and any other rough markings.

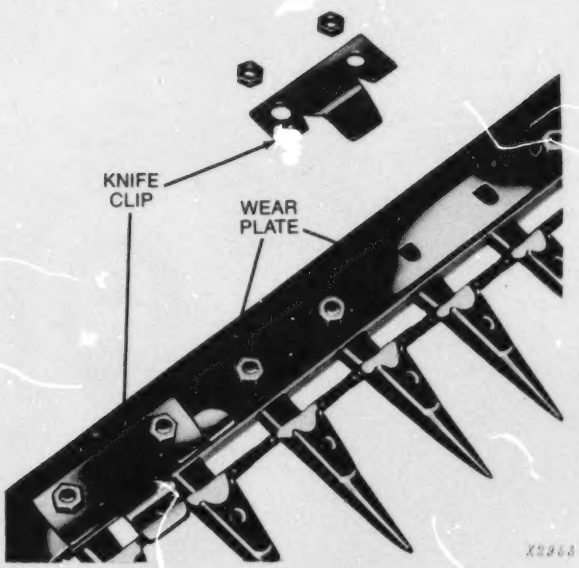

Fig. 52 — Guard Replacement

The *ledger plates* must be kept in good condition. Poorly maintained ledger plates cause ragged cutting and side draft. Since most ledger plates are serrated, they cannot be sharpened, only replaced. The first thing to determine is how they are held in place.

Quick-attach ledger plates are held in position by pins, springs, or by wedging. On those using pins, replace the plate by driving the pin up from the bottom of the guard then driving it back into position to hold the new plate. Plates held by springs merely require snapping out the old plate and putting in the new one.

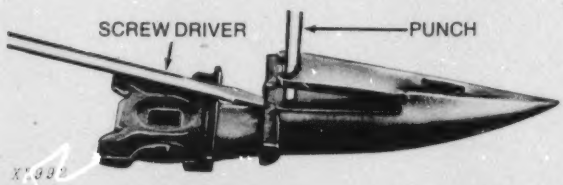

Fig. 53 — Removing Ledger Plate

Remove plates that are wedged into position with a screwdriver (Fig. 53). Raise the rear edge of the plate and pry against the lip of the guard to slide it out.

To replace the new plate, drive it forward until it drops into position. Then set the plate by tapping on the material around the rear of the plate.

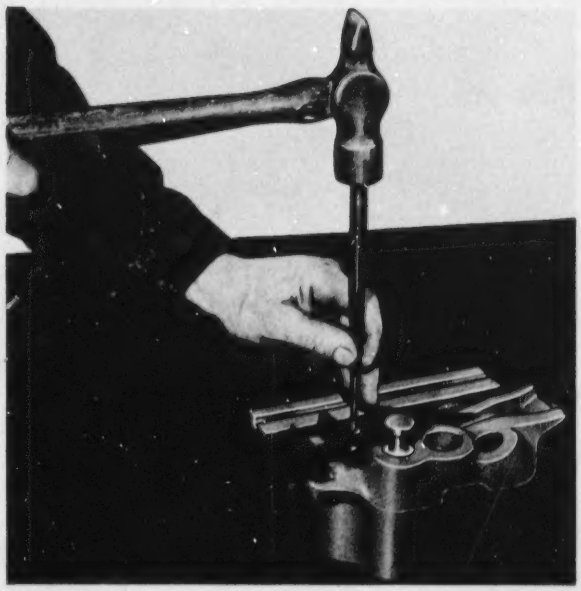

Fig. 54 — Removing Riveted Ledger Plate

Ledger plates that are riveted may be replaced without removing the guard from the cutter bar, but it is easier if the guard is removed.

Place the guard on a solid surface with a recess in the center and drive the rivet out from the top (Fig. 54). A guard repair block comes in handy for this job.

If you cannot drive the rivet out, you may be forced to drill it out. If it is worn away, countersink the rivet hole on the lower side (face) of the guard with a countersink or a 5/16-inch twist drill. This will allow you to smooth the bottom of the guard and have no rivet head protruding.

Place the new plate in position and insert the rivet from the top.

Fig. 55 — Forming Rivet Head

Form rivet head on the bottom of the guard with a hammer by holding the guard on a solid surface, top side down (Fig. 55).

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File both the top and bottom of the rivet so it is smooth with the plate and guard.

SERVICING THE SHOES

Some mowers have inner and outer shoes which have ledger plates. When these plates become worn or damaged, plugging will occur.

Replacing Inner Shoe Plate

To replace the inner shoe plate, remove the shoe from the cutter bar. Remove parts that will interfere with removal of the ledger plate.

Fig. 56 — Removing Rivets From Inner Shoe

Place the inner shoe in a vise and drive out the rivets holding the plate (Fig. 56).

Remove the shoe from the vise and place a piece of steel (½-inch thick, 2-inches wide, and about 8-inches long) in the vise. This piece will be used as a backup bar.

Position a new plate on the shoe with new countersink rivets. Turn the shoe over, face down, so that the backup bar is under the ledger plate. Peen over the rivets on the bottom of the shoe (Fig. 57).

Replace all parts removed from the shoe and reinstall it on the cutter bar.

Fig. 57 — Replacing Ledger Plate On Inner Shoe

Replacing Outer Shoe Plate

To replace the outer shoe plate, remove the shoe from the cutter bar. Remove parts that will interfere with removal of the ledger plate.

Fig. 58 — Removing Rivets From Outer Shoe

Place the inner shoe in a vise, bottom side up, and chisel the head off the rivets (Fig. 58). Punch out the rivets and remove the old plate. Remove the shoe from the vise and place a piece of steel (½-inch thick, 2-inches wide, and about 8-inches long) in the vise. This piece will be used as a backup bar.

Position a new plate on the shoe with new countersunk head rivets. Turn the shoe over, face down, so that the backup bar is under the ledger plate. Peen over the rivets on the bottom of the shoe (Fig. 59).

Replace all parts removed from the shoe and reinstall it on the cutter bar.

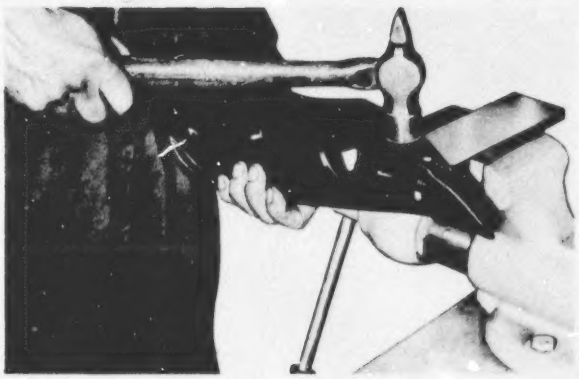

Fig. 59 — Replacing Ledger Plate On Outer Shoe

SUMMARY

For good operation, the cutter bar must be properly adjusted and maintained, and part must be replaced when necessary. Worn parts cannot do their job efficiently and continued operation can cause more damage. *It never pays to try to get by with worn parts.*

Proper adjustment is probably the most important factor in long cutter bar life with a minimum of repair. If a cutter bar is not kept in adjustment, repair and replacement will result in costly maintenance.

To summarize: Maintenance of the cutter bar consists of keeping the knife sharp, repairing or replacing worn or damaged parts, and lubricating as recommended by the manufacturer.

Repair or replacement of parts is often a matter of judgment. When in doubt whether to repair or replace, always replace the parts in question. This avoids unnecessary breakdowns.

TEST YOURSELF

QUESTIONS

1. What is the primary disadvantage of pitman-type drives?

2. What are the functions of the knife hold-down clips and wear plates?

3. What is cutter-bar lead?

4. Name two basic methods of establishing correct cutter-bar lead.

5. In what sequence should knife sections be replaced when replacing all sections?

6. Why is it necessary to shear knife section rivets off rather than punch them out?

7. What is the recommended procedure for removing a knife?

(Answers on next page.)

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ANSWERS

1. Pitman-type drives usually vibrate more than pitmanless drives, and cannot be operated as fast due to the hammering effect of the pitman thrust.

2. The knife hold-down clips and wear plates *hold the knife in proper position* for the best cut.

3. *Cutter bar lead* is an adjustment that aligns the cutter bar with the pitman when the pressure of the crop pushes the cutter bar back.

4. The two methods for establishing cutter bar lead are the parallel-line method and the straightboard method.

5. When replacing all knife sections, *alternate* sections should be removed and replaced. Then the remaining sections can be replaced in the same manner. This eliminates rivet-shift and keeps the knife straight.

6. If the rivets are punched out, the rivet holes in the knife back may be enlarged. This will permit the sections to shift and cause rivet failure.

7. First block up the cutter bar. Remove the drive arm or pitman. Grasp the knife by its back side with *both hands* and pull the knife out. Maneuver any sections that hang up with the blocks. This avoids placing your fingers in a vulnerable position.

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SPRAYING NOZZLES / PART 2

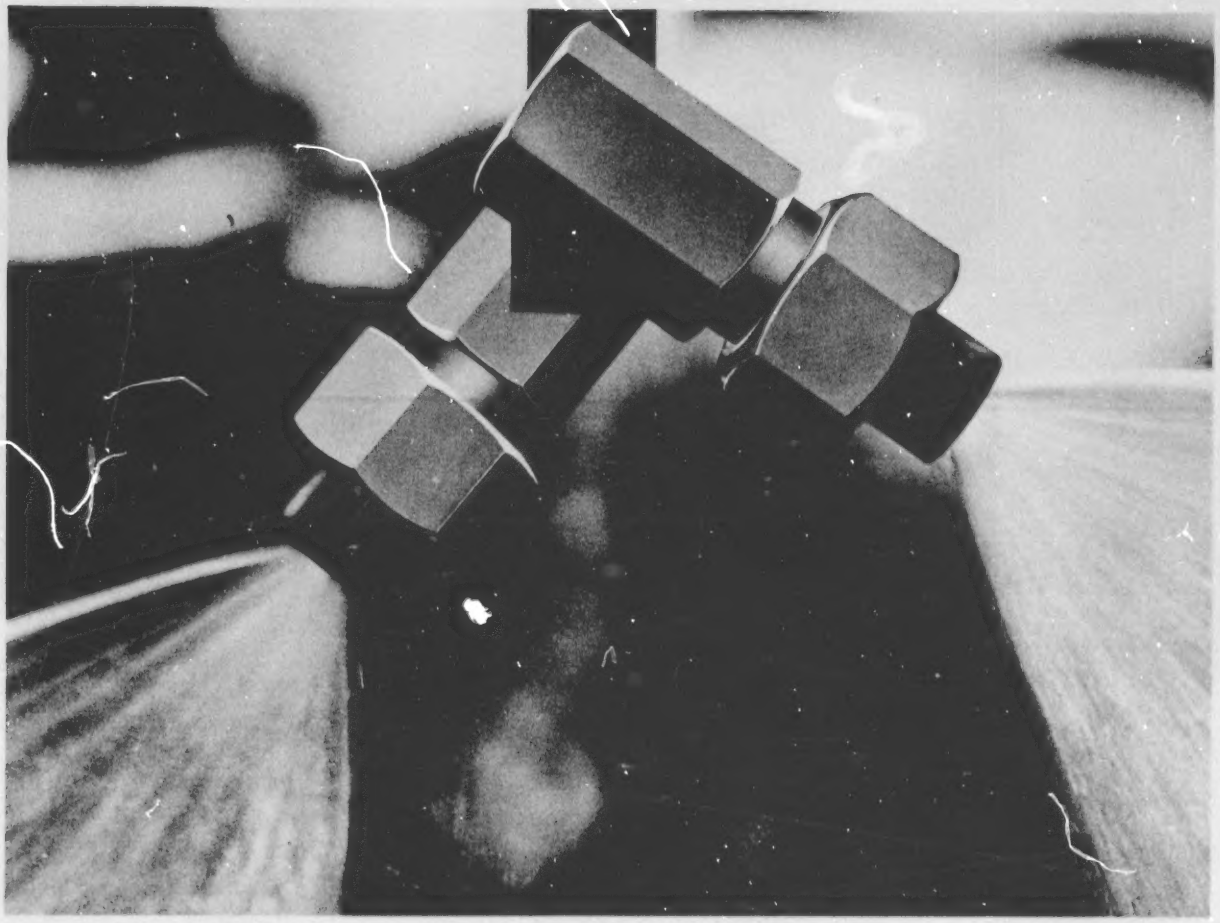

Fig. 1 — Spraying Nozzle At Work

INTRODUCTION

Spraying nozzles can apply an accurate amount of liquid uniformly over a large area.
To do this, a nozzle must atomize a liquid into small droplets. Then it must spray these droplets in a specific pattern at a particular flow rate.

The nozzle does four basic jobs:

1. **Meters liquids at a certain flow rate.**
2. **Atomizes liquids into droplets.**
3. **Disperses the droplets in a specific pattern.**
4. **Propels the droplets for proper impact.**

Let's examine these four jobs in terms of nozzle *flow* rate and *atomizatic*

First — flow rate.

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FLOW RATE

The nozzle flow rate is chiefly controlled by the metering passages. However, pressure, density and viscosity also affect the flow rate.

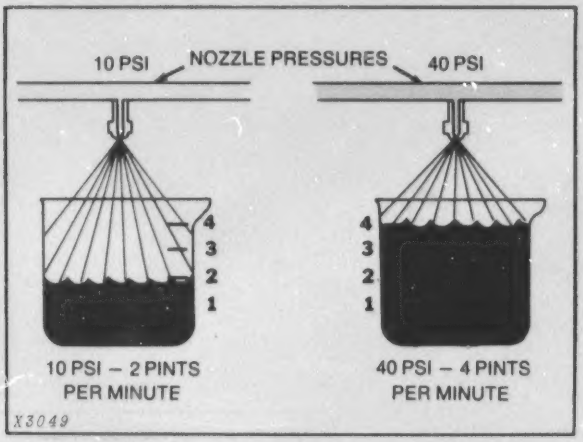

Fig. 2 — Flow Rate Is In Proportion To Pressure

With most nozzles, flow rate is in proportion to pressure. **The higher the pressure, the higher the flow rate.**

To double the flow rate, the pressure must be increased four times (Fig. 2). Conversely, to decrease the flow rate by half, the pressure must be reduced to one-fourth of the original pressure.

Density and viscosity of the fluid can affect the flow rate in different ways. In some conditions, the flow rate will actually increase with more viscosity. Usually, however, **the more dense and viscous the liquid, the lower the flow rate.**

ATOMIZATION

Atomization is the liquid break-up caused by the tearing action of air. As the liquid exits from the nozzle, it is in unstable sheets or jets, which collapse into tiny droplets. Usually the finer droplets are toward the inside of the spray pattern, while the larger droplets are at the outer edge.

The size of droplets is affected by nozzle rating, pressure, viscosity, and surface tension.

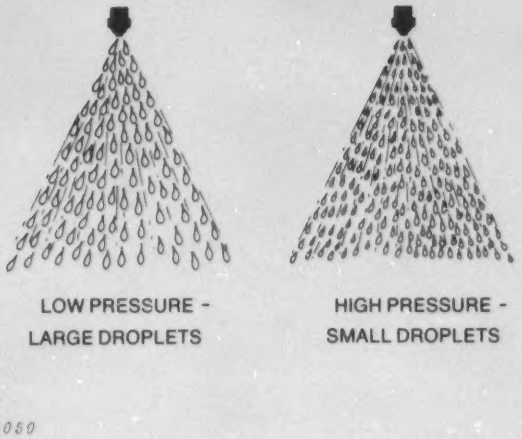

Fig. 3 — Droplet Size Decreases As Pressure Increases

As pressure is increased, the droplet size decreases for a finer spray (Fig. 3). A limit is eventually reached where more pressure has little effect on finer atomization.

With more viscous or dense fluids, larger droplets occur. Usually higher pressures are required to break up the liquid into the desired spray.

While surface tension does not affect atomization as much as viscosity, this tension can be difficult to break up if the liquid is denser. Another liquid of the same viscosity but with less surface tension can be atomized more easily.

In some spray applications, such as insecticides, a finer droplet size is required in order to obtain good spray impact and coverage of the plant. But with greater atomization, the spray is more susceptible to wind drift. **Therefore, protective clothing and a respirator must be worn by the operator.**

Coarser droplets are generally recommended for the spraying of herbicides. The use of tips with larger orifices (such as flooding tips) and lower operating pressures (15 to 50 psi) will give the coarser droplet while reducing harmful spray drift.

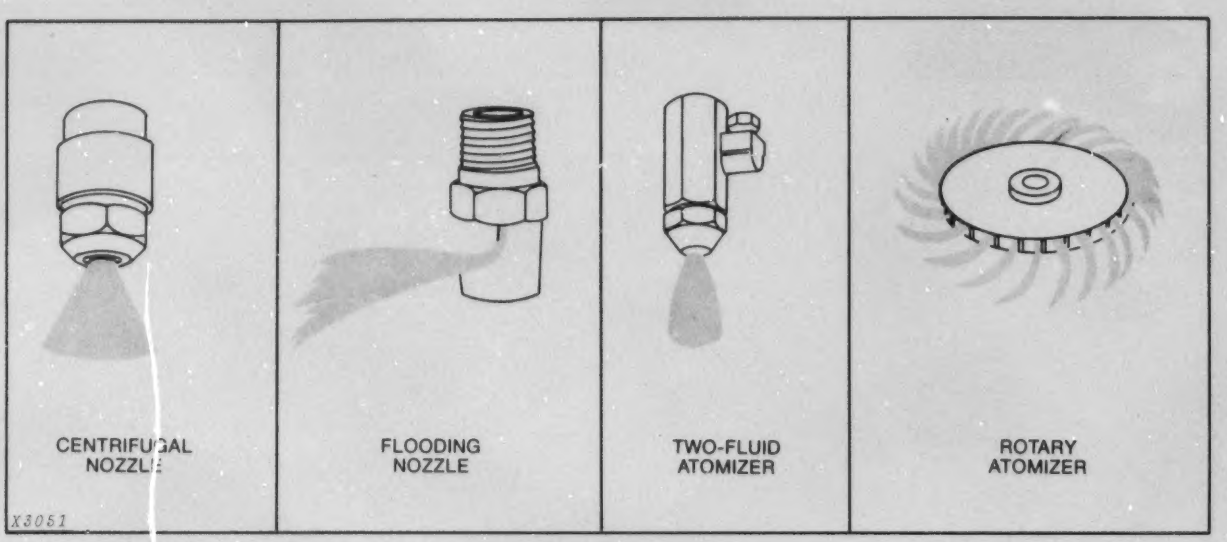

Fig. 4 — Common Types Of Nozzles

TYPES OF NOZZLES

Spraying nozzles are made in several designs. Each type atomizes fluids in a specific way to meet different job requirements.

The common types of nozzles are:

- **Centrifugal nozzles**
- **Flooding nozzles**
- **Two-fluid atomizers**
- **Rotary atomizers**

CENTRIFUGAL NOZZLES are most common (Fig. 4). They are made in a wide range of spray angles and with various shapes of spray patterns and capacities.

FLOODING NOZZLES produce a spray in the shape of a fan or sheet (Fig. 4). They may also be called "fan-spray" nozzles.

TWO-FLUID ATOMIZERS can produce very fine droplets and will handle dense fluids. However, they require more power than other types.

ROTARY ATOMIZERS are for big jobs, spraying thousands of gallons per hour by centrifugal force in a 360-degree spray pattern.

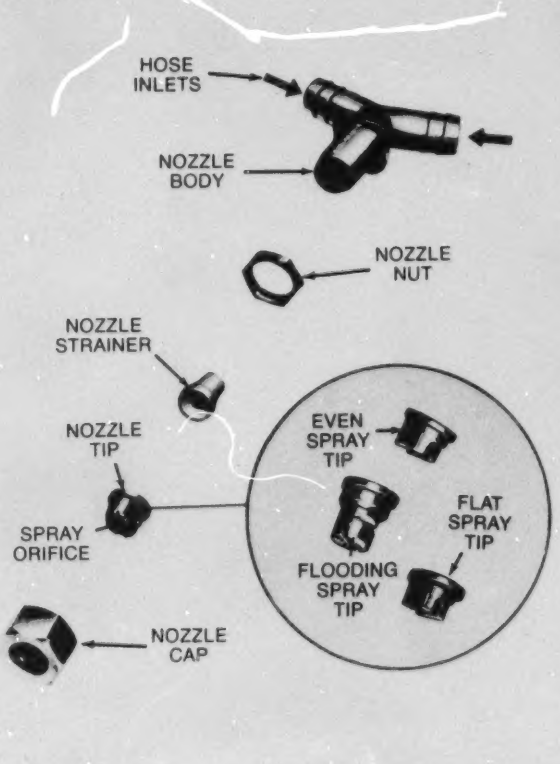

Fig. 5 — Typical Spraying Nozzle Assembly

Since we are concerned mainly with centrifugal pressure nozzles and flooding nozzles, we will discuss them in more detail later.

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PARTS OF A NOZZLE

Nozzles have four basic components (Fig. 5).

- **Body**
- **Strainer**
- **Tip**
- **Cap**

Let's look at each part in detail.

NOZZLE BODY AND CAP

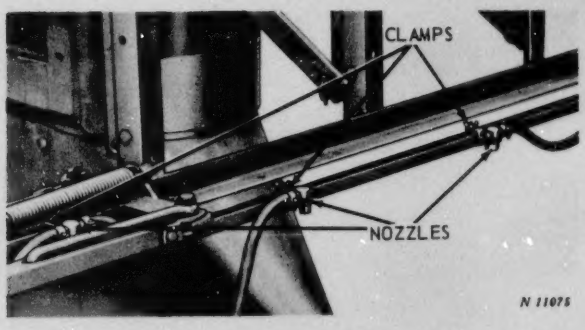

Fig. 6 — Nozzles Clamped To Dry-Type Boom

Nozzle bodies and caps are usually made of brass, aluminum, stainless steel, zinc-plated steel, or nylon. These bodies and caps are designed to accept several different tips that spray various patterns (see Fig. 5). Usually the nozzle body is either attached to a dry-type boom or a wet-type boom. On the dry-type boom, the nozzle bodies are clamped to the boom and the nozzles are supplied with fluid by hoses (Fig. 6).

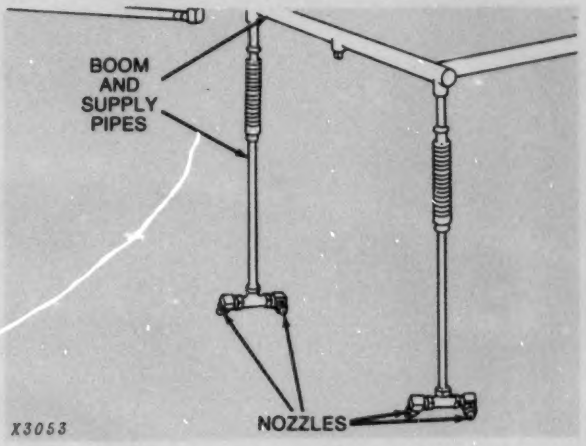

Fig. 7 — Nozzles Installed In A Wet-Type Boom

On the wet-type boom, the nozzles are attached to a pipe which provides the liquid supply to each nozzle while functioning as part of the boom structure (Fig. 7).

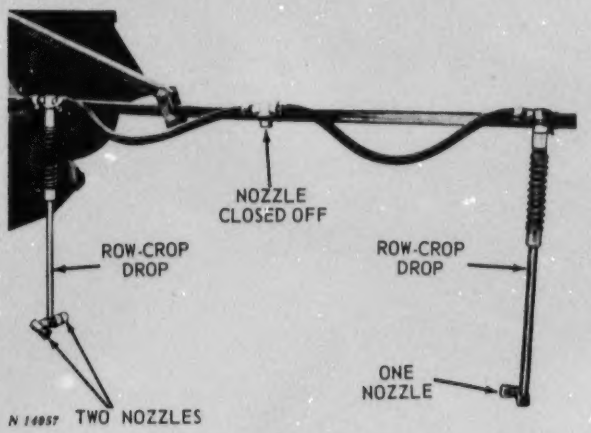

Fig. 8 — Swivel Nozzles On Row-Crop Drops

Another kind of nozzle body is the *swivel type*. The swivel bodies are attached to the lower end of a row-crop drop. This allows more accurate placing of spray for use after the crop has emerged, such as for insecticide spraying of the plants. A double swivel nozzle is used between the rows to direct the spray in both directions while a single swivel nozzle is used at the outer ends of the boom.

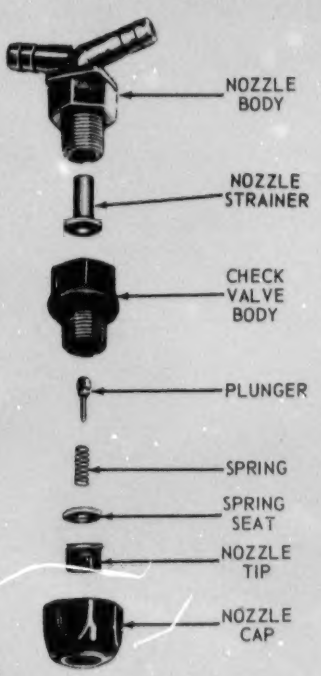

Fig. 9 — Plunger-Type Nozzle Check Valve

In some spraying operations, it is desirable to have a quick shut-off at each nozzle to avoid nozzle dripping at row ends or grass waterways. Here check valves can be placed in the nozzle body (Fig. 9).

When the line pressure drops below a certain low pressure, the valve will automatically shut off all flow. There are three main devices used to do this — the plunger-type (Fig. 9), the ball-type, or the diaphragm-type check valve.

The plunger and diaphragm check valves are contained in their own body and attach to the nozzle body. However, the ball check valve can be used in place of the tip strainer.

NOZZLE STRAINERS

Nozzle screens or strainers (Fig. 10) provide the last screening of foreign material in the spraying system. This helps to prevent clogging at the nozzle tip.

On most *screens,* the screen material is stainless steel with mesh sizes of 50, 100, or 200 (number of openings per linear inch). The screen assembly is normally cylindrical in shape and fits inside most nozzle bodies. This type of nozzle screen is used more with liquid-concentrate types of chemicals. When using powder chemicals which are abrasive, a slotted *strainer* should be used (Fig. 10, right) These strainers have a larger mesh size equivalent to 16, 25 or 50 mesh.

When selecting a nozzle screen, choose the screen which has a mesh opening just a little *smaller* than the orifice in the nozzle tip. However, the smaller or finer the mesh, the more likely it is to clog.

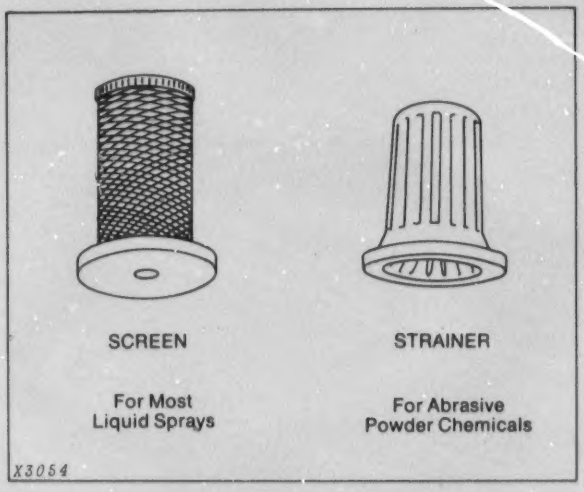

Fig. 10 — Nozzle Strainers

A *clean* screen or strainer is vital for efficient and accurate distribution of the spray material. They should be checked and cleaned often. If not, erratic spray patterns, improper metering and delivery, or complete clogging of the nozzle will occur.

NOZZLE TIPS AND SPRAY PATTERNS

Centrifugal and flooding nozzles have tips which provide five basic spray patterns (Fig. 11).

The centrifugal pressure nozzle produces a hollow or solid cone spray pattern. The flooding nozzle produces flat, even, or flooding spray patterns. With all these nozzles, various flow rates and spray angles are available.

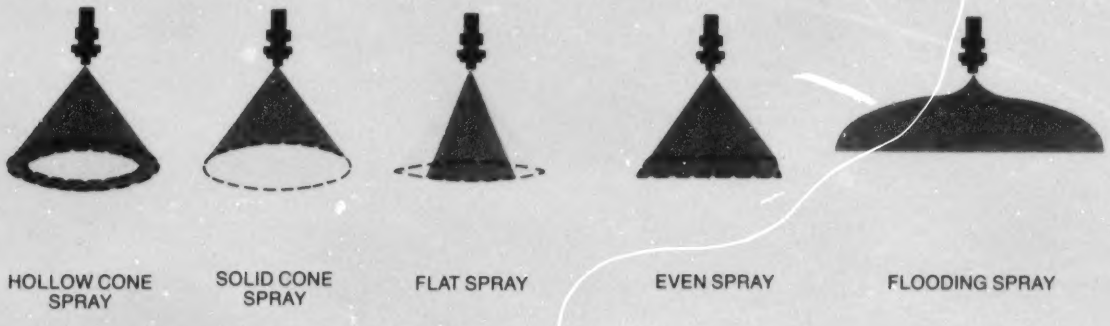

Fig. 11 — Types Of Spray Patterns

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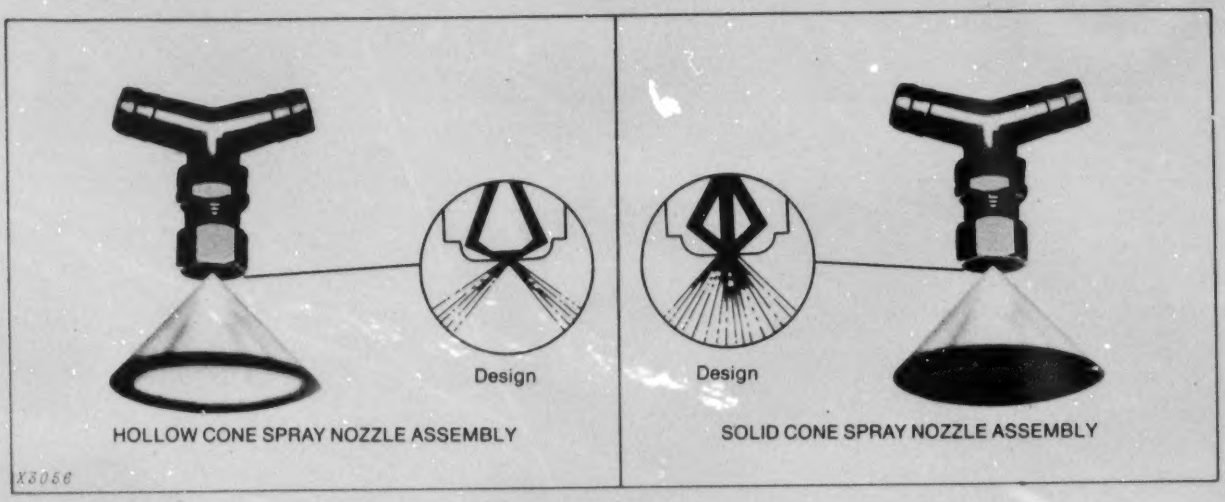

Fig. 12 — Hollow And Solid Cone Spray Pattern Nozzles

Hollow And Solid Cone Spray

Hollow and solid cone nozzles (Fig. 12) are popular for row-crop spraying of high-volume fungicides, insecticides and herbicides (Fig. 13). These nozzles are generally used on spray booms or spray guns. They are more resistant to clogging from abrasive wettable powders than other nozzles.

X3057

Fig. 13 — Row-Crop Spraying With Cone-Type Nozzles

These nozzles deliver a cone spray pattern consisting of large droplets at low pressures. The spray angle may be from 30 to 120 degrees. The hollow cone nozzle (Fig. 12) produce a more uniform and more finely atomized spray than the solid cone nozzle.

Notice in Fig. 12 how the spray pattern is achieved. Hollow cone nozzles contain a core that swirls the liquid around before exiting the orifice. The solid cone nozzle is similar. It, however, has a hollow core than supplies a jet of liquid which fills in the hollow cone.

Flat And Even Spray

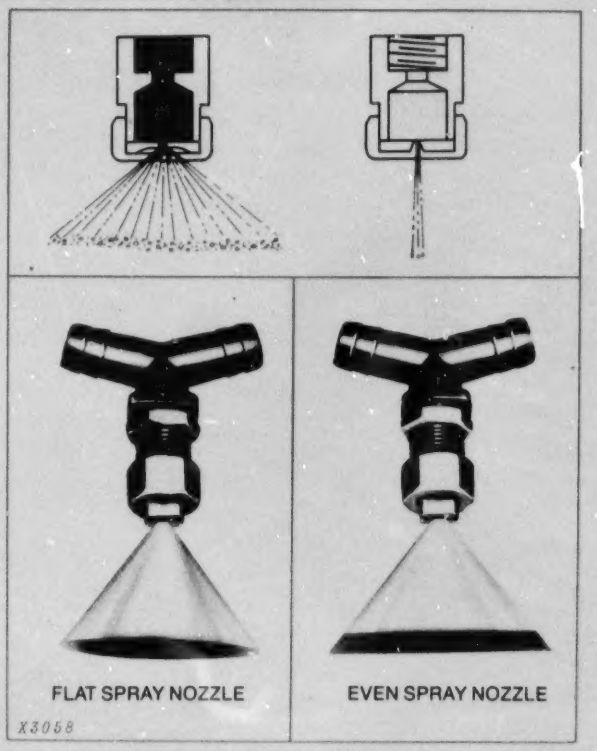

Fig. 14 — Fan Spray Pattern Nozzle

Flat and even spray patterns are produced basically by a fan-spray nozzle (Fig. 14).

The **flat** spray pattern is used for applying all types of fertilizers, herbicides, and insecticides. It may also be used on boom sprayers, broadcast sprayers, planters, or cultivators.

X3059

Fig. 15 — Overlapping Boom Spraying

This nozzle sprays a fan-shaped pattern with a gradually tapered edge. The spray angle may be between 65 and 80 degrees. When this pattern is properly overlapped, it provides even distribution of the liquid (Fig. 15).

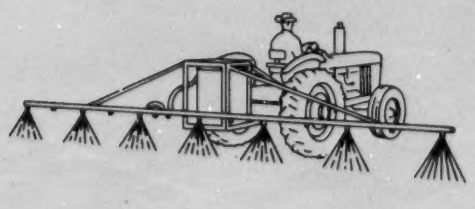

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Fig. 16 — Band Spraying

The **even** spray pattern is used for applying the desired liquid in a even band (Fig. 16). Often it is used with planter attachments for row patterns.

The even spray gives a fan-shaped pattern with uniform distribution across its full spray width. The spray angle may be between 80 and 95 degrees.

Flooding Spray

Flooding nozzles deliver a wide, flat spray with large droplets (Fig. 17). As the liquid discharges from a plain orifice, it strikes a curved deflector which deflects the spray about 75 degrees from the nozzle axis as shown. The spray angle may be between 70 and 160 degrees. It can be mounted in various positions to provide different patterns.

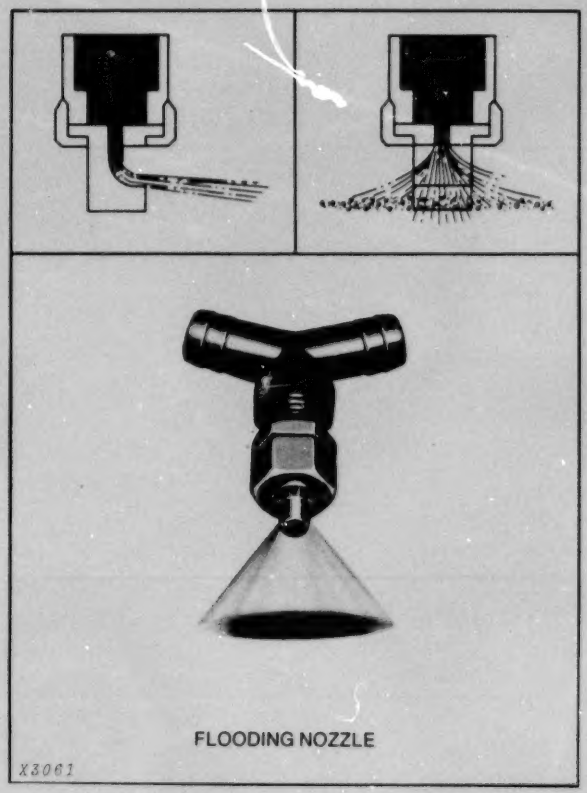

Fig. 17 — Flooding Spray Pattern Nozzle

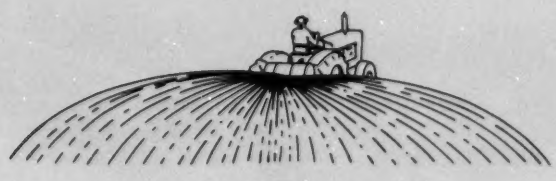

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Fig. 18 — Boomless Broadcast Spraying

Flooding nozzles are often used for broadcast application of fertilizers and defoliants. Also they are used in post-emergence application of herbicides. Usually these nozzles are mounted on boom sprayers or lay-by rigs. Sometimes they are used alone as in boomless broadcast spraying (Fig. 18).

OTHER TYPES OF SPRAY EQUIPMENT

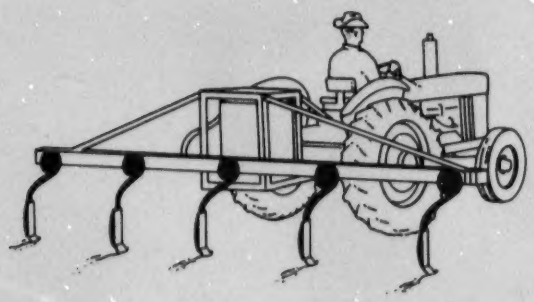

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Fig. 19 — Subsoil Application Of Liquid Fertilizer

Special equipment is available for other application methods, such as applying liquid fertilizer with subsoil attachments (Fig. 19).

These attachments carry the liquid under pressure into the soil. Nozzle check valves are normally used to prevent spray from dripping when turning at row ends.

Dribble applicators and wide-spray jets are also available for specific requirements.

X3064

Fig. 20 — Hand Spraying Gun

Spray guns are used by hand where selective spraying is desired (Fig. 20).

These guns can be used for fence rows, small weed patches, and even for insect control in barns, etc.

The hand gun may be used alone or connected to a mounted spray boom. Most guns contain their own check valves.

SELECTION OF NOZZLES

Nozzles should be selected to give the proper droplet size and application rate within the recommended range of pressures.

The nozzle controls the amount of chemical applied, the uniformity with which the chemical is applied to the treated surface, the thoroughness with which the surface is covered, and the safety with which the chemical is applied.

Nozzle tips are made from different materials — brass, aluminum, nylon, stainless steel, hardened stainless steel, chrome plated brass, and brass with a tungsten carbide orifice.

Brass and aluminum tips are the cheapest, but the metal is softer and the tips wear faster. Tips made from harder metals cost more but they wear longer.

As nozzle tips wear, the rate of application increases. Tests have shown that some wettable powders may wear nozzle tips sufficiently to increase the rate as much as 12 percent after spraying 50 acres. For this reason, frequent calibration of equipment is advisable.

Always select spray nozzles to give the spray delivery patterns desired.

CALIBRATING THE APPLICATION RATE

To perform accurately in the field, the flow rate of sprayer nozzles must be known. Let's look at suggestions for calibration.

As we have mentioned, flow rate is affected by nozzle passages, tip design, pressure, viscosity and density.

Since most application rate charts are based on the flow characteristics of water, the sprayer must be calibrated for the addition of chemicals. This calibration also checks for variations in nozzle output and in equipment performance.

Many studies have determined that volume and pattern may vary considerably, particularly when wettable powders are used. Therefore, the sprayer should be calibrated daily and the operating pressure be gradually lowered to compensate for wear until the nozzle tips require replacement.

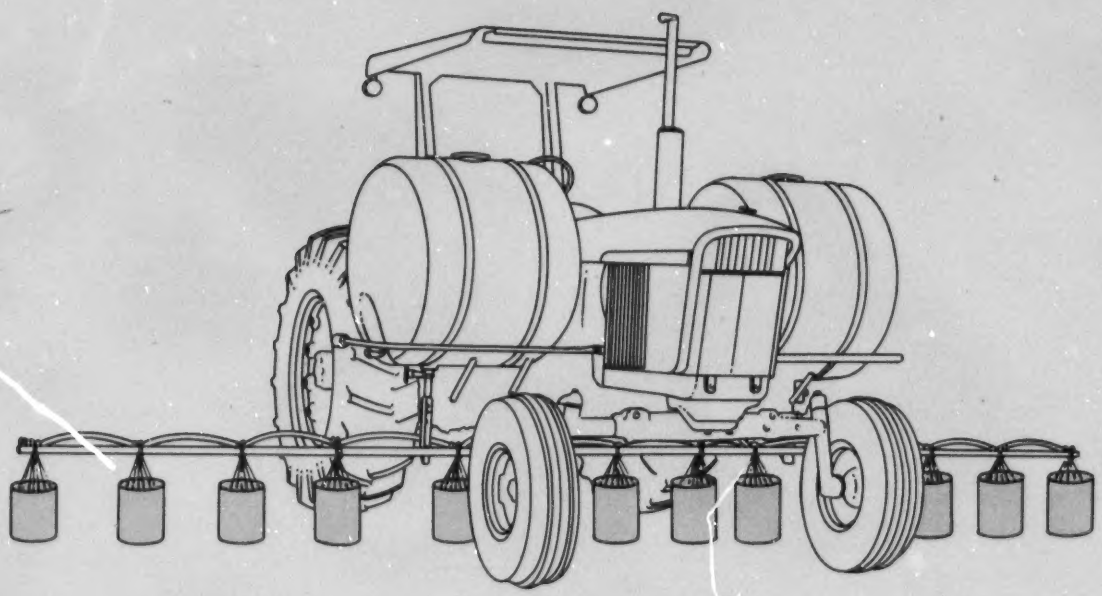

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Fig. 21 — Collecting Spray From Each Nozzle

There are several calibrating methods; however, the method which follows is simple and one of the most direct means of calibrating. The only measuring devices necessary for calibrating are:

1) Clock or watch with a sweep second hand.

2) Plastic container graduated in fluid ounces (quart capacity).

3) Tape measure.

CHECKING NOZZLE TIP FLOW RATE

Before calibrating the sprayer, check the entire length of the spray boom for equal spray distribution at each nozzle tip:

1) Install the selected nozzle tips and partly fill the sprayer tank with clean water.

2) With the sprayer stationary and operating at the recommended pressure, collect spray from each nozzle tip (Fig. 21) for equal amount of time (15 to 30 seconds).

3) Record each sample and compare with the average.

4) Replace any tip having an uneven spray pattern or an output of 10 percent less than or greater than the average.

SAFETY RULES

CAUTION: Agricultural chemicals can be dangerous. Improper use can injure persons, animals, plants, soil or other property. Handle and apply with care.

When mixing, calibrating, or working around chemicals, use the following equipment and supplies:

- **Protective clothing; cap, gloves, respirator, goggles, footwear, etc.**
- **Clean water supply**
- **Detergent**

If spray material comes in contact with the body, wash off contact area IMMEDIATELY with clean water and detergent.

Select an area where you can safely fill, flush, calibrate, and decontaminate the sprayer without pesticides drifting or running off to contaminate people, animals, vegetation, or a water supply. Select an area where it will be impossible for children to come into contact with pesticides.

To reduce spray drift hazards:

- **Use large nozzle tips operated at lower pressures.**
- **Do not operate sprayer at pressures over 50 psi.**
- **Do not make spray applications when winds exceed 10 mph.**

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CALIBRATION DISTANCE CHART							
Broadcast Spraying						Band Spraying	
Row Spacing (Inches)	Distance (Feet)	Row Spacing (Inches)	Distance (Feet)	Row Spacing (Inches)	Distance (Feet)	Band Width (Inches)	Distance (Feet)
40	102	32	128	24	170	14	292
38	107	30	136	22	186	12	340
36	113	28	146	20	204	10	408
34	120	26	157				

HOW TO CALIBRATE

To help describe the method of calibration, we will use a specific example. Be sure to observe all safety rules for sprayers.

1. Fill sprayer tank with properly mixed chemical solution to be sprayed. In our example, we used a chemical that requires an application rate of 10 gpa (gallons per acre).

2. Measure calibration distance in the field to be sprayed. See chart below for required distance for a given row spacing for broadcast spraying or for a given band width for band spraying. (Our sprayer is equipped with two nozzles per 40-inch row (a nozzle spaced every 20 inches). Mark the distance (102 feet for 40-inch rows).

3. Move sprayer across the marked distance at the desired operating speed (in our case, 8 mph) and initial pressure setting (32 psi in our example). See your operator's manual for exact recommendations. Record the travel time in seconds. We recorded 9 seconds to travel the measured distance.

4. With the sprayer stationary, turn on the spraying system and obtain the same pressure as was used in the test run. Collect spray from nozzle or nozzles from one row for the same number of seconds as the travel time.

5. Measure the total spray collected in FLUID OUNCES. The number of fluid ounces represents the number of GALLONS PER ACRE, (for example, 10 ounces collected equals 10 GPA).

6. If the fluid ounces collected do not agree with desired application rate, adjust pressure setting and re-collect spray. *Remember: raising the pressure setting increases application rate; lowering the pressure decreases the rate. Also, to double the flow rate, the pressure must be increased* **four** *times.* Use nozzles with higher flow rates rather than increasing the pressure of the sprayer beyond the manufacturer's recommendations.

7. For our example, the spray we collected was 11 ounces from the two nozzles. We reduced the operating pressure to 25 psi, and the collected spray then totaled 10 ounces. This represents the desired application rate of 10 gpa. This sprayer should now be operated at 8 mph and 25 psi.

NOZZLE ADJUSTMENT AND CARE

Proper nozzle adjustment and care are required to maintain good nozzle performance.

The distance of the nozzle tips from the sprayed surface, the angle of spray, and the spacing of the nozzles all have a bearing on proper spray coverage. Nozzles must be spaced equally along the spray boom and positioned correctly in relation to the row. On wet-type booms, the nozzle position is fixed and cannot be changed. However, on dry-type booms the nozzle is clamped to the boom structure and can be adjusted.

PROBLEMS WITH NOZZLES

The illustrations which follow show the most common problems with booms and flat spray nozzles. Similar problems may occur with other types of nozzles.

Worn Or Plugged Nozzles

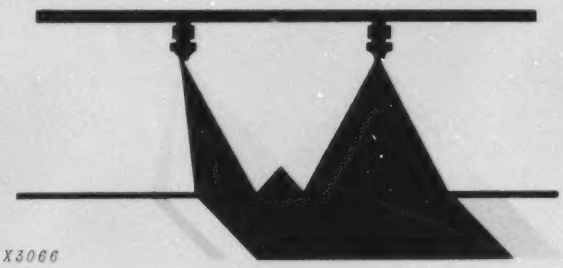


Fig. 22 — Worn Or Plugged Nozzles

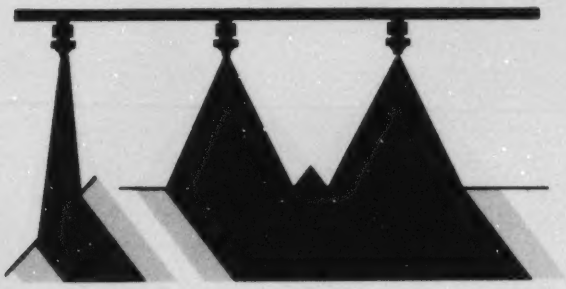
Worn or plugged nozzles will result in leaving untreated strips as seen in Fig. 22.

Clean nozzles periodically — particularly when applying wettable powders. A worn nozzle tip may also result in over-application and many times cannot be detected by observation. Repeated calibration of the sprayer will detect worn nozzle tips.

In event of nozzle clogging or other system malfunctions, shut down sprayer and pump, and release pressure from system.

Never place nozzle tips or other parts to lips to blow out trash. Have spare tips available for replacement.

Misaligned Nozzles

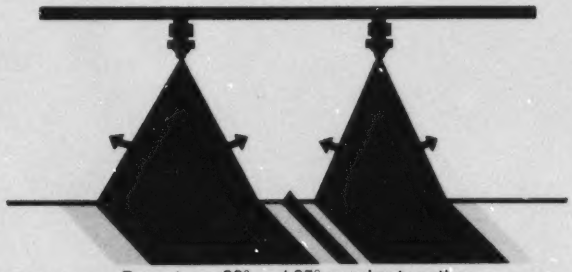


X3067

Fig. 23 — Misaligned Nozzles

If flat type nozzle tips are not aligned parallel with the boom, coverage will not be completed (Fig. 23). Wrench flats are provided so that the tips can be properly aligned.

Improper Nozzle Tips

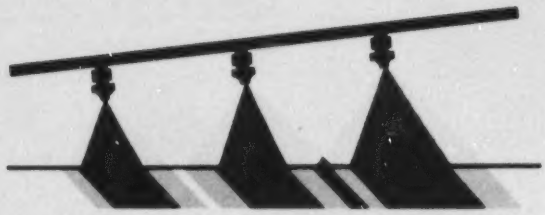


X3068 Do not use 80° and 65° nozzles together

Fig. 24 — Improper Use Of Nozzle Tips

Nozzle tips of various size and angle must NOT be used on the same boom (Fig. 24). Irregular spray coverage will result.

Spray Boom Not Level

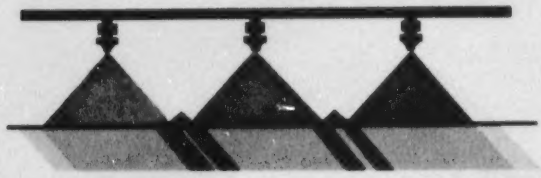


X3069

Fig. 25 — Spray Boom Not Level

If the boom is not level or parallel to the sprayed surface, coverage will be irregular (Fig. 25).

Spray Boom Too Low



X3070

Fig. 26 — Spray Boom Too Low

If the boom is carried too high or too low, uneven patterns and coverage will occur (Fig. 26). Follow the manufacturer's recommendations for carrying height.

CLEANING OF NOZZLES

Clean nozzles periodically during the use season. Failure to keep them clean may result in irregular spray patterns and eventually the nozzle will become plugged.

Disassemble the nozzle assembly and clean the parts with a soft bristle brush, toothbrush, or toothpick and clean water or safe solvent. **Do not use metal probes of any kind to clean tips and screens.**

At the end of the use season, remove and clean nozzle tips and screens and store them in a jar of diesel fuel.

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CALIBRATION FORMULAS

$$\text{gpm/nozzle} = \frac{7.5}{\text{sec/pt}}$$

$$= \frac{\text{gpa} \times s \times w}{5{,}940}$$

$$\text{gpa} = \frac{5{,}940 \times \text{gpm/nozzle}}{s \times w}$$

$$= \frac{44{,}500}{s \times w \times \text{sec/pt}}$$

$$= \frac{43{,}560 \times \text{gal discharged}}{\text{swath width (ft)} \times \text{length of run (ft)}}$$

$$\text{mph} = 0.682 \times \frac{\text{length of run (ft)}}{\text{time (sec)}}$$

gpa .....gallons per acre, broadcast basis
gpm .....gallons per minute
mph .....miles per hour
sec .....seconds
pt .....pints
ft .....feet
s .....ground speed (miles per hour)
w .....nozzle spacing on boom or band width (inches)

TEST YOURSELF

QUESTIONS

1. Name three of the four basic functions of a nozzle?

2. Fill in blanks with "faster" or "slower": The higher the nozzle pressure, the ..... the flow rate.

3. True or false? "The higher the nozzle pressure, the finer the spray."

4. How many times must the pressure be multiplied to **double** the flow rate?

5. What is used in a nozzle for quick shut-off?

6. True or false? "As nozzles wear out, the flow rate normally decreases."

7. Which of the following may be used to clean nozzles.

a) Toothpick
b) Wire brush
c) Metal probe
d) Toothbrush

8. Why should a sprayer be calibrated?

ANSWERS

1. The four basic functions of a nozzle are: metering liquid, atomizing liquid into droplets, dispersing the droplets in a specific pattern, and propelling the droplets for proper impact. (Any three for correct answer.)

2. "Faster"

3. True.

4. *Four* times.

5. A *check valve.*

6. False.

7. Only the toothpick (a) and the toothbrush (d) are safe for cleaning spray nozzles. Metal probes or wire brushes can damage the nozzles and their orifices.

8. It is necessary to calibrate a sprayer because nozzle flow rate charts are based on the flow characteristics of water alone. Calibration also checks variations in nozzle output and in equipment performance.

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